THE RESOURCES OF THE EMPIRE

A business man's survey of the Empire's resources prepared by the Federation of British Industries.

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CHEMICALS

BY

A. W. ASHE AND H. G. T. BOORMAN, A.I.C.

WITH A FOREWORD

BY

H.R.H. THE PRINCE OF WALES, K.G.

AND GENERAL INTRODUCTIONS BY

THE RT. HON. SIR ERIC GEDDES, G.C.B.
(President of the Federation of British Industries)

SIR MAX MUSPRATT, BART.
(Vice-President of the Federation of British Industries and Chairman of the Association of British Chemical Manufacturers)

AND

ROBERT GROSVENOR PERRY, C.B.E.
(Chairman of the National Sulphuric Acid Association)

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FOREWORD

BY

H.R.H. THE PRINCE OF WALES, K.G.

No business man—especially should he contemplate an extension of activities—can afford to dispense with periodical stock-taking. The necessity for this applies equally to a country or empire, particularly when recovering from a devastating war that has resulted in heavy liabilities and dislocated the accustomed routine of trade and commerce. We are all proud of the British Empire, embracing more than a quarter of the world's land area and a similar proportion of its inhabitants, but very many of us fail to realize the infinite variety and vast extent of the Empire's natural products, which are capable of being made self-sufficing.

The volumes of this Series pass in review the material resources of the Empire, and constitute, as it were, an Imperial stock-taking. They deal with food and raw materials of every kind, summarize the present condition of inter-Imperial trade, and indicate where further developments are possible.

At the present moment, when our great British Empire Exhibition is imminent, they should be of special interest both at home and overseas. It gives me great pleasure to recommend them to all those who have at heart the proper organization of the Empire's natural wealth.

GENERAL INTRODUCTION

BY

THE RIGHT HON. SIR ERIC GEDDES, G.C.B.

In undertaking the preparation of this Series the Federation of British Industries has, I am convinced, rendered a really practical service to business men throughout the Empire.

Hitherto, there has been no standard work of reference giving the information which ought to be in the possession of business men all over the world regarding the resources of Great Britain and the other countries of the Empire in the materials of industry.

It is true that there are some excellent monographs describing in general terms the resources of isolated parts of the Empire, and a very few dealing comprehensively with individual products, but, apart altogether from the fact that the sum total of the information contained in existing publications falls hopelessly far short of what is requisite, such information as exists is hardly prepared in a form adapted to the requirements of the practical man who wants neither a bare table of statistics about the products essential to him in his business nor a mere general description of the extent of the resources of a given country in those products. On the contrary, the business man wants information not only as to the available supplies of his raw materials, but as to the quality of the supplies produced in different parts of the world, as to the amount of the undeveloped resources, as to the transport facilities, as to the local conditions of labour, etc., and as to the chances of present supplies available for import in this country being absorbed in the near future by local demands. In other words, he wants particulars of all those factors which have to be taken into account in the ordinary course of business, and he wants those particulars arranged in an accessible form.

The aim of this Series has been to give this information in this form, and thus to provide not only for our own use, but for the use of traders all over the world, a compendious Buyers' Guide to our Imperial resources. I venture to think that the present is a very appropriate time for this undertaking. It is not only that all our thoughts are being turned towards the idea of Empire trade and Empire development by the great Exhibition which is shortly to be opened, and which will be the most impressive demonstration of our Imperial productiveness that the world has yet seen. The whole trend of economic circumstances is forcing us in the same direction.

The world war has disastrously affected the Continent of Europe as a market for the manufactured goods of Great Britain and the products of the British Dominions. Even foreign countries which were neutral in the great struggle have suffered in the same way, though in a less degree. Our trade

with the Far East and South America has suffered serious diminution, and though more than five years have now elapsed since the cessation of hostilities the resumption of normal conditions seems but little nearer. Moreover, foreign tariffs are rising higher and higher against us all over the world. Meanwhile our own productive capacity has been substantially increased and our population has grown to such an extent that we have now two million more mouths to feed and a million more men to employ than we had in 1914. It seems clear, therefore, that we need some reorientation of our commercial policy, and the obvious direction for this seems to be the cultivation of our own inheritance. A study of the facts shows that there is good hope in such a policy. Britons in all parts of the world are bound together by ties of sentiment and custom which neither distance nor difference of conditions can seriously weaken. Not only has the tremendous investment of British money in our Overseas Dominions bound us with a golden chain: there are a thousand invisible impulses always strengthening the bond. Even in 1913 our trade with the Empire was about 25 per cent. (imports) and 36 per cent. (exports) of our total world trade. The following tables show this in more detail with a comparison with the figures for the latest twelve months available. From these it will be seen that our imports from Imperial sources show a substantial advance over pre-war, the export figures remaining about the same.

PERCENTAGES OF IMPORTS FROM VARIOUS SOURCES.

Consigned from—	*October*, 1922 *to* *September*, 1923.	*Year* 1913.
British India	6·0	6·3
Self-governing Dominions	16·3	13·3
Other British countries (except Hong Kong)	5·3	5·3
Europe	33·2	40·4
United States	19·6	18·4
South and Central America	10·8	10·0
Other countries	8·8	6·3

PERCENTAGES OF EXPORTS (U.K. GOODS) TO VARIOUS DESTINATIONS.

Consigned to—	*October*, 1922, *to* *September*, 1923.	*Year* 1913.
British India	12·2	13·4
Self-governing Dominions	18·0	17·5
Other British countries (except Hong Kong)	5·7	5·4
Europe	34·2	34·4
United States	8·0	5·6
South and Central America	8·8	10·6
Other countries	13·1	13·1

The following table shows the areas and populations of the British territories on the various continents:

SUMMARY OF AREA AND POPULATION (1921-22).

	Area (Square Miles).	*Population.*
Great Britain and Ireland	121,633	47,308,000
Europe	120	234,000
Asia	2,123,418	332,772,000
Africa	3,822,667	50,119,000
America	4,009,996	11,142,000
Australasia	3,278,917	7,795,000
Total	13,356,751	449,370,000

The following table shows the approximate purchases of British goods per head of population for the first three quarters of 1923:

	£ per Head.
India, British	0·2
Federated Malay States	0·5
Australia	7·8
New Zealand	12·3
Canada	2·3
Hong Kong	7·7
Union of South Africa	2·1

The most striking features here are the huge acreage, small population, and large volume of purchase per head of Australasia, and the relatively huge populations and small volume of purchase in the Eastern territories, with Canada and South Africa occupying an intermediate position. I will recur to this contrast later.

Finally, a few figures may be given indicative of the percentage of various important world supplies either produced or available within the Empire:

	1915.	1921.
Copper (long tons)	100,000	46,000
Percentage of world production	10·2	8·5
Lead (long tons)	—	199,400
Percentage of world production	—	22·9
Tin ore (long tons)	68,300	46,800
Percentage of world production	53·9	42·2
	1913.	1923.
Wool (including alpaca, etc.) (lbs.)	5,414,067	14,077,339
Percentage of world production	74·6	77·1

It is clear, therefore, that there is an almost unlimited field for expansion of our Empire trade, whilst in many lines this possibility of a self-supporting Empire should be realizable. On the side of Great Britain the requisite productive power already exists. Overseas the position is somewhat different, and it seems clear that the requisite development of the purchasing power of the Overseas Dominions can only be produced by a gradual development of the resources of those Dominions, the surest way to which will be an increase in our own consumption of their products. There are two distinct problems, one for the tropical and one for the temperate and subtropical countries.

In the former any substantial increase in the white population is hardly to be expected, since the bulk of the work of the country must in such climates always be done by the native races. The purchasing power of these territories can therefore only be developed by the steady development of their material

resources. This, of course, means recourse to British capital, if Great Britain is to get the greatest advantage from the development and if our Imperial ideal is to be fulfilled. In our present economic condition this, of course, presents some difficulty, but if we can carry out this programme, there will follow a greater demand for British plant, machinery, shipping, rolling stock, etc., as well as a gradual increase in the consuming power of the natives.

In the temperate climates the quickest means to both our objectives lies in the speedy increase of the white populations. Nothing is more striking in the figures given above than the quantity of British goods purchased per head of these great peoples. But it is useless to attempt to stimulate emigration from this country to the Dominions unless there is a real demand for the services of the migrants when they arrive. Such a demand will only arise *pari passu* with the development of the resources of the country concerned.

The deduction to be drawn from the above considerations is obvious. How the required results are to be pursued is a more difficult question. This is not the place, nor am I the person, to embark on questions of political controversy. I will only point out that, whatever method be adopted, accurate and comprehensive knowledge of the facts is absolutely essential. (All those who are engaged in business, either here or overseas, whether it be in finance, in production, in merchanting, in transport, or in insurance, should be informed of what the different parts of our great Empire can produce, and the conditions under which production must take place and those under which the produce can be brought to market. There should be a general knowledge, too, of the amount of foreign competition with which our products and materials have to contend.)

In all my experience, whether on the railways, in the turmoil of the Great War, in Government, or in commerce, I have been continually impressed with the vital importance of accurate and comprehensive statistical knowledge—and, I am afraid, too often impressed with the difficulty of getting it.

This Series is an endeavour to supply such information regarding our Imperial resources. It cannot, unfortunately, be maintained that the results are in every case all that one could wish. However, this very inadequacy is perhaps the clearest justification for the series. The fact that complete information cannot be given shows how necessary it is that all available information should be collected and made public. Only in this way can attention be called to what is wanting and the deficiencies made good. If the Series proves as successful as I hope it may, and believe that it will, it should become a permanent institution, and it should be possible gradually to make good what is now wanting in future issues, so that eventually we may have in it a standard work of reference, which should be indispensable to all those interested or engaged in Imperial commerce or development, whether he be business man, student, or administrator.

March, 1924.

INTRODUCTORY REVIEW

BY

SIR MAX MUSPRATT, Bart.

Chairman of the Association of British Chemical Manufacturers

In this admirable volume, to which I have been asked to write a foreword, the reader will find a great store of statistics and other valuable information relating to the chemical industry of this country.

It is gratifying to find the industry dealt with comprehensively, because it is sometimes forgotten that the ramifications of the British chemical industry are so wide, and that its foundations are so secure. The general public, as a rule, are content to accept such opinions as are served up to them daily in the form of news, and the controversies that have arisen periodically during the last few years regarding such specialized branches of the industry as dyes and fine chemicals, and the relative weakness of our position in these fields, have led to somewhat distorted views of the position as a whole. It is well to take stock of ourselves occasionally, and I commend the study of this volume as an important and much needed illustration of the value of the chemical industry to this country.

The history of chemical manufacture in this country is a long and honourable one. I hope that some day a worthy record will be written of the romantic achievements in industrial technology during the end of the eighteenth century and the beginning of the nineteenth century.

It is a record of which we are justly proud. It is true that the work on the manufacturing side was carried out under conditions of freedom that are to-day impossible in an organized community. Before the days of the Alkali Acts, Ministries of Health, and other recognized and necessary safeguards, technical efficiency counted for little against output when it was practically impossible to keep pace with the demands of a rapidly increasing industrial population. Nevertheless, the inventive genius of the pioneers of our industry; their indomitable pluck in facing great difficulties, and the tradition of commercial probity which they built up, established a chemical industry in Great Britain which attained such importance in the economic system of the country that one of the greatest Prime Ministers laid it down as an axiom that the position of the chemical industry was the sure index of the industrial position of the country. But though in those days of rampant individualism technical efficiency was not regarded as of primary importance, yet as the industry has developed we recognize more and more the technical debt we owe our predecessors.

The industry in its early days was divided roughly into two main classes or divisions. There was what is now generally called the heavy chemical industry,

which included alkalies and acids, and there was the manufacture and production of the primary coal tar products. In these main divisions this country quickly established a supremacy in the world—a supremacy which it retains to-day. Out of the discovery of aniline colours by Perkin, an Englishman, in the middle of the nineteenth century, grew the great dyestuffs industry. It is not in my province to analyze either the causes or the economic justification for the neglect of this section of the industry, as also of the fine chemical section, in this country during the years preceding the war. I shall have something to say later of the far-reaching nature of the consequences of this neglect and of the remedial steps taken since then.

The fundamental chemicals of civilization may be divided roughly into three classes—acid, alkali, and the products of coal distillation already referred to.

Sulphuric acid is, of course, a fundamental chemical. Owing to its properties it does not lend itself readily to world trade, but the products for which it is used do, and it has been well described as "the life blood of an industrial nation, in both peace and war." A special article by Mr. R. G. Perry, Chairman of the Sulphuric Acid Association, dealing with sulphuric acid, will be found in this volume, so that it is unnecessary for me to do more than refer thus briefly to this important class.

For the production of alkali and coal tar products Great Britain had the natural advantages of unlimited supplies of brine (saturated solution of salt), coal, and limestone in close proximity. The salt deposits of Cheshire, Lancashire, and Durham have proved to be an invaluable source of wealth to the country. Their value to us has been as great as the more notorious potash deposits at Stassfurt have proved to Germany. In the beginning of the nineteenth century there was a very heavy tax on salt, which effectively obstructed development, and the foundation of the chemical industry as we know it to-day coincides with the abandonment of that tax.

In alkali, England has always led the world. For almost a century the Leblanc process of manufacture was supreme. Invented by a Frenchman in the throes of the French Revolution, its practical development was carried out by my grandfather, James Muspratt, an Irishman of English descent, closely followed by others such as Gamble, an Irishman, and Gossage, an Englishman, and the distinguished Scotsman, Charles Tennant. The Leblanc process, to modern ideas, is unduly complicated, but these very complications made it the mother of almost unlimited by-products which were developed by other Englishmen, notably Weldon, Deacon, and Chance. With each step in development, chemical engineers arose to deal with the various problems, and the solution of these problems and the control of the processes have called into existence and maintained a body of experts in inorganic chemistry, which is a real national asset.

The next great step in alkali manufacture was the ammonia soda process, originally patented by two Englishmen, Dyer and Hemming, brought into practical industry by a Belgian, Solvay, and perfected at Northwich in Cheshire.

The final development of the simultaneous production of the two products alkali and chlorine was the electrolytic process. Here the invention was of continental origin, but the practical development was in Runcorn, Cheshire,

though hard on its heels came the process of Hargreaves and Bird, and certain American processes, some of them economically practical. The best of the latter has been adopted on a large scale at Widnes and Newcastle, with the result that in alkali Great Britain has every range of up-to-date process; has complete control of the neutral markets of the world; and even in the highly protected countries, such as the U.S.A. and certain continental countries, is looked upon as a reservoir in times of shortage, and as a foe to be conciliated in days of competition.

I have purposely accentuated the part which individual Britons have played in establishing this position—it is a great tradition of individual effort and inventive genius.

Throughout the last hundred years the alkali industry has steadily advanced. Many large consuming countries have developed alkali works behind specially erected tariff walls, but the world's consumption has so constantly increased that, apart from local disturbances due to changes of process, the total outlet is constantly increasing, and even at the present moment of general depression is greater than it has ever been before.

Based upon cheap acid and alkali, important businesses have grown up which are really branches of chemical industry, developing their own technical and research work, notably soap and glass, paper and artificial silk, galvanizing and tin plate, while the heavy chemical industry plays a very important part in the textile world, far more important than the dyestuffs of which, at the moment, we hear so much. In all these daughter industries Great Britain is still economically and practically supreme wherever the consumer is free from prohibitive as distinct from revenue duties.

The last fundamental group embraces the products of the distillation of coal. On the specifically chemical side these are the by-products of two important industries, the gas industry and the coke industry. From the economic standpoint the gas industry is the more important. The distillation of coal gas was first adopted in England, and was so thoroughly developed, first for light, and later for heat, that in spite of the competition of electricity, the gas works and gas consumption of Great Britain exceed that of any other country of the world, at any rate, per head of population. But the coke industry is a good second, and though for certain special qualities coke is still made without recovery of by-products, the vast bulk of the coke used in the iron and steel and other industries is made in recovery plants.

These by-products fall into two classes: (1) Ammonia Liquor; (2) Benzol, Naphthalene, Anthracene, etc.

The principal outlet for Ammonia before the war was in the form of ammonium sulphate, an important fertilizer, and this was marketed all over the world, no less than 75 per cent. of the total production in England being exported, but its vital national importance was only fully realized during the war, when vast quantities of nitrogen products were required for explosive purposes. The only other great source of raw material was nitre from Chile, which, in spite of the submarine campaign, poured into the country. In the early days of the war this was more convenient for the production of most explosives, but the possible

success of a submarine blockade made it necessary to explore the conversion of ammonia into nitric acid, and this problem was successfully solved.

Germany had a much more difficult problem, as she had no nitre, and only limited quantities of ammonia, and it must be admitted she solved it brilliantly by the conversion of atmospheric nitrogen into ammonia and nitric acid.

It is obvious that from a strategic point of view this country could not continue to rely on uninterrupted seaborne supplies of nitre, and towards the end of the War steps were taken by the Government to erect a large factory for the production of synthetic ammonia from atmospheric nitrogen, at Billingham on the Tees. The factory was still incomplete at the armistice, and all the work was stopped. It was ultimately purchased by Messrs. Brunner, Mond and Co., who have shown great enterprise in tackling this difficult problem, and although output has not yet quite reached serious commercial scale, there seems adequate promise of the successful establishment of a process for the fixation of atmospheric nitrogen in this country. Since the war, also, great strides have been made in the perfection of the process for the production of nitric acid from ammonia. The economic utilization of synthetic ammonia or ammonia as a by-product from gas works is of prime importance, and it is satisfactory to record large scale production of nitric acid from this raw material.

Taking the second class of distillation products—benzol, naphthalene, anthracene, etc.—these form the basis of the dye and fine chemical products, but benzol and its homologues have other uses, notably for disinfectants, and unfortunately, from a chemical standpoint, as a substitute for petrol. In consequence it has a luxury value which raises serious questions with regard to its economic value for the dye industry.

Up to the primary combinations the technique of these coal tar products is highly developed, the quality excellent, and their production in large quantities assured, owing to the stability of the gas industry.

With this strong position in alkali, acid, nitrogen compounds, and coal tar primary products, Great Britain is fully equipped with the raw materials for a successful dye and fine chemical industry. Much progress has been made, though we are yet far short of the position which this country should hold in these fields.

The manufacture of dyestuffs and the fine chemical industry have both a national aspect and an industrial aspect. On the outbreak of war we found ourselves woefully short of dyes with which to keep our textile industries going, by which our overseas credit was seriously threatened, and as a result our supplies of food and raw materials endangered; on the national side we found ourselves equally short of the trained personnel in organic chemistry so essential in modern warfare.

The firm intention was then expressed by all schools of thought that never again should we allow ourselves to be placed in this position of disadvantage. But the dye industry, on the other hand, has had to face great difficulties, some unforeseeable, others which might have been avoided.

Of the first, the unparalleled depression in the textile industries is a chief cause. In spite of the very real advance in range and quality of dyes made in Great Britain, owing to which the percentage of home-made dyes is now 80

per cent. of the home consumption, as against 20 per cent. before the war, this consumption is, at present, far too low for large scale economical production. This factor is, no doubt, transitory, but the time of recovery may be long, and in some way or another the results of several years of building up should be conserved.

With regard to the avoidable difficulties, one feels some reluctance in treading on delicate ground, but it would be idle to deny that the dye industry, with a few notable exceptions, is not quite rising to its possibilities as a national industry, and is not taking full advantage of that spirit of co-operation which has done so much for other branches of chemical industry, including the fine chemical industry.

So far as help can be given by Parliamentary legislation, the question of dyes and fine chemicals has been dealt with by two entirely different methods: the question of dyes by prohibition subject to license; the fine chemicals by the Safeguarding of Industries Act. In principle the first was the sounder; the second in practice has produced more satisfactory results.

The actual assistance rendered by the Safeguarding of Industries Act to fine chemicals has been small and uncertain, but the psychological effect has been enormous, and all the latent possibilities of Great Britain have been developed with absolutely miraculous results. Great Britain has now a fine chemical industry manned scientifically and with vision which can stand four-square to the world, though it probably still requires the almost intangible support of the Safeguarding of Industries Act, or some better considered method of support.

It is impossible in a review, however brief, of chemical industry to omit reference to the fertilizer trade; first, because of its importance to the nation, and, secondly, because of the exceptional circumstances under which this branch of industry is labouring. There are few trades that have suffered more from post-war conditions than the fertilizer trade. By reason of falling exchanges and the consequent low comparative cost of labour abroad, the British superphosphate manufacturer has been forced to sell his product against foreign competition at a price which has realized less than the actual cost of raw materials, exclusive of manufacturing cost. This has already resulted in the closing of works in various parts of the country, and it is obvious that unless financial conditions in Europe improve, the closing of works will be rapidly extended. Fortunately, there appear signs of the approach of financial stabilization in Europe, and, given equal terms, there is no doubt of the ability of British superphosphate makers to maintain the position of their trade in the markets of the world.

Those who visit the British Empire Exhibition will be able to realize something of what the British chemical industry stands for in the economic system of the country and of the Empire. It is a "key" industry, not only in the limited sense of Parliamentary language, but in the full sense that in some way or other every other industry is linked up with the chemical industry, and that its prosperity and development are of vital importance to our national welfare. With regard to its war possibilities, other countries realized its importance before we did. It is no exaggeration to say that the power and extent of her chemical industry was the measure of Germany's strength in the war. She dictated the terms on which the war should be fought, and those terms were on the basis of her specially encouraged and highly developed chemical industry. Her advisers,

however, reckoned without the resiliency of British organization and the elasticity of the mind of the British industrialist, and the final victory of the Allies was won on Germany's own chosen ground. It is not, therefore, unfitting to recall, with pride, the part that the chemical industry of this country played in the winning of that victory.

The contribution of the industry was twofold. First, there was the readiness and skill to undertake successfully the supply of new and enormous demands which involved far-reaching adjustments throughout every branch of industry, and secondly, there was the supply of experienced and capable technical chemists and chemical engineers. But there is no need at this date to labour the importance of a national chemical industry, on the ground of national defence, to those who have seriously considered the matter. It suffices to say that, with the possible exception of dyestuffs, recent developments in the industry have considerably enhanced our national security.

It has been one of the most remarkable features of modern industrial history in this country that national questions are now considered nationally—with a gratifying development of the spirit of co-operation. Evidence of this is found in one direction in the trade associations which have arisen since the war. Perhaps the most typical, and without doubt one of the most successful, of these is the Association of British Chemical Manufacturers. Having nothing to do with the vexed question of prices, it has been the means of bringing all chemical manufacturers into close personal touch and has provided the machinery for dealing co-operatively with all questions affecting the industry. It has brought a national sense into the conduct of the industry. That the results have been good cannot be denied. The individual manufacturer has benefited by reason of mutual consultation; the State has benefited in having a fully equipped and authoritative organization for the purpose of advice and information, and the consumer has gained by the greater efficiency of the industry.

It is not out of place to draw attention to the remarkably effective part which the British chemical industry is taking in the British Empire Exhibition at Wembley. This exhibit is, in itself, one of the practical results of the national association. It exemplifies the practical value of closer co-operation between individual manufacturers, but it also instances the possibilities of closer co-operation between the industry and pure science.

There is, to-day, greater community of interest and outlook between our universities and our industry than has ever been experienced before. The universities realize there is much to be learnt from the manufacturer, and, on the other hand, the manufacturer realizes more and more the value of the pure research of the universities. Owing to the abnormal conditions after the war, when, under the Government scheme for university education of ex-servicemen, an enormous number of chemists who had reached the degree standard were suddenly produced from the universities, the supply of chemists has actually exceeded the demand; but with the return of normal conditions the training of research students, who will be ultimately absorbed in industry, is a matter of very great importance, and it is a matter in which the co-operation of the industrialist and the university professor is essential. If the chemical industry of this country

is to hold its place in the markets of the world it can only do so by research, and still more research. More particularly does this apply to the development of the dyestuffs industry. With well-directed research and the earnest and willing co-operation of the more established branches of the chemical industry, I have no fear of the ultimate successful establishment in this country of a great dyestuffs industry.

Another point of interest in dealing with post-war conditions is the relationship of the Government to industry. On the side of research the Government has set up the Department of Scientific and Industrial Research, which has already accomplished much in many directions where research was apt to be neglected. In the case of the chemical industry, which has always attached great importance to research within itself, it has necessarily not done much directly. Its value to us is in the evidence it offers of the sympathetic interest of the Government in the affairs of industry. This same sympathy is evident in other Government departments, but there is still much room for closer co-operation in dealing with national interests.

In bringing this short survey to a close it is well to remind ourselves of the part played by chemicals in the foreign trade of this country. For many reasons, into which at the moment it is not necessary to enter, the continent of Europe does not play the same part in the English chemical trade as it at one time did. Tariff walls have been built up by all the principal countries of the continent, and under the shelter of these contrivances many continental markets built up a heavy chemical trade. In South-Eastern Europe, in the countries of the Levant, and in Northern Europe, the British manufacturer still has many interesting points of contact. Outside of Europe he still enjoys the advantages of the work which was done for him by the early workers in chemical industry in the United Kingdom. Mexico, Central America, and South America still trade with him, and the very names by which the pioneers introduced themselves to buyers in these parts are still household words. The Colonies and Dominions, South Africa, Australia, Canada, and New Zealand are still buyers of British chemicals; while in India, China, Japan, the Dutch East Indies, and the Straits Settlements, not only has the position of the British manufacturer been maintained, but it shows progress to an extent which would astound the forerunners in the industry. Chemicals have thus brought the United Kingdom into business relations with almost all peoples, and have added to those foremost of civilizing factors better mutual knowledge and appreciation between the peoples of the world.

MAX MUSPRATT.

March, 1924.

By ROBERT GROSVENOR PERRY, C.B.E.

Chairman of the National Sulphuric Acid Association.

SULPHUR

A survey of the resources of the British Empire from an economic, industrial, or progressive point of view shows no element more conspicuous by its comparative absence, yet at the same time, with the possible exception of iron and coal, more important to the development of an industrial community, than Sulphur.

Looked at from the point of view of a fundamental raw material, Sulphur must be given a place of the first importance in relation to industry, not so much because of its use as such, but because of the essential and very widely needed uses to which the secondary products that are derived from it.

Lord Beaconsfield once said that " there was no better barometer to show the state of an industrial nation than the figure representing the consumption of Sulphuric Acid per head of population," and this axiom, although mentioned thirty years ago, is even to-day more true than at the time at which he gave utterance to it.

There is hardly an important British industry which is not directly or indirectly dependent to some extent on Sulphur, and not only does Sulphur form a raw material in each of these industries, but it is the only raw material which could perform the functions that are required, and no substitute has been, or, so far as is known, can be, found which even at greater expense would play the same part in our industrial development.

First and foremost among the derivatives of Sulphur comes Sulphuric Acid, a commodity which penetrates the very basis of our industrial life to an extent almost unequalled by any other substance.

Sulphuric Acid is the medium for the production of our greatest soil fertilizers, Sulphate of Ammonia and Superphosphate, without which our land could not produce the quantity of human food per acre which is so necessary to the safety and preservation of our position among the nations of the world.

Sulphuric Acid enters almost as largely into our great metal industries. Galvanized iron, as a case in point, could not be produced without it; and if we are to consider war, then it would be true to state that among the first problems that this country would have to face would be an adequate supply of Sulphur. High Explosives, Propellants, Bombs, Missiles of all descriptions, and, finally, Poison Gases, must all be considered in their preliminary stages of manufacture from the point of view of Sulphur or Sulphuric Acid.

Dye production, on which our great Textile industry so very much depends, again, is open to the same attack. Sulphur and its derivatives form a foundation without which the structure of dye manufacture could neither be supported nor maintained.

Again, the Textile industry is in itself dependent to a large extent upon Sulphuric Acid in the several stages of its operations, for not only is the Acid required in the production of the dye to colour the finished product, but it is also used at the beginning of all textile operations in the cleaning and bleaching of the raw cotton and wool before it reaches the spinners' hands.

It is quite impossible to enumerate in complete detail the whole of the very varied uses to which Sulphuric Acid is put in British industries, but in addition to the foregoing remarks it may be useful to mention that this Acid is essential to the production of Aerated Mineral Waters, Artificial Silk, Soap, Glass, and Tanning materials; that it is required for the refining and treatment of all grades of Oil and Motor Fuel; also, it is essential to the electrical storage batteries, without which the usage of electricity for light, power, and heat would in many cases be most seriously hampered.

A further derivative of Sulphur which plays a large part in industry is Sulphur Dioxide, upon which such trades as Paper-making, Refrigerating, Bleaching, Food-preserving, Photography, depend; and, again, we have Sulphur Chloride required by the Rubber industry for the process of vulcanization, without which Rubber itself would lose much of its importance.

Sufficient has, perhaps, now been shown to prove the vitally important part in British industries which Sulphur and its products play, and it may, therefore, be useful now to turn to the sources of supply from which it is obtainable, and, incidentally, the forms in which it arises.

Sulphur within our shores—*i.e.*, the British Isles—may be said to arise for all practical purposes solely in our coal, but, most unfortunately, the lines of development upon which our social and economic life has progressed have led us to the position where it is necessary to state that only 6 or 7 per cent. of the Sulphur which our coal contains is recovered and used as Sulphur for the purposes above enumerated. Approximately 200,000,000 tons of coal are mined and consumed annually in the United Kingdom, and approximately this quantity of coal contains 1,000,000 tons of Sulphur. Of this great quantity of coal, 200,000,000 tons, some 12,000,000 to 15,000,000 tons are dealt with by the Gas industry, and to this industry alone we are able to look for the recovery of the Sulphur in the coal. The Gas industry recovers from the coal it carbonizes some 60,000 to 70,000 tons of Sulphur, which Sulphur arises under the trade description " Spent Oxide " and is utilized in the manufacture of Sulphuric Acid, giving the country approximately 220,000 tons of Sulphuric Acid, or in a normal trading period about one-seventh of the Acid consumed and needed by British industry. It is a matter of the most profound concern that our other industries consuming coal, which almost entirely do so for the purpose of the thermal units derived, are still unable to devise an economic means whereby the Sulphur content of that coal can be recovered instead of, as at present, being allowed to burn and pass to waste through the chimneys and flues of their boilers and furnaces. Were it possible to recover the Sulphur content of the coal consumed within our shores the United Kingdom would be not only independent of the danger and difficulty of securing Sulphur overseas, but would be in a position to sell for export Sulphur in large quantities. Bearing in mind that at the

present time only approximately 6 per cent. of this Sulphur is recovered, it will be seen how great a future lies before those scientists who may be charged with the problem of efficiently treating those coal supplies, which under the present order of things may fairly be described as the nation's economic life blood.

The final section of this brief survey must be devoted to an indication of where and how Sulphur arises in the world, and it may at once be said that there are only two well-known established deposits of pure Sulphur to which attention need be paid; indeed, to-day the world may be described as absolutely dependent for its requirements of elementary Sulphur on the deposits existing in the United States of America, along the shores of the Gulf of Mexico, and on the Sulphur fields of Sicily.

In addition to these sources Sulphur is obtainable in the form of a metallic sulphide in Spain, Norway, and Sweden, reaching this country under the description "Iron Pyrites," from which the Sulphuric Acid manufacturer burns out the Sulphur, handing on the resultant iron oxide residues to the blast furnaces of the iron-masters.

These, then, are the very few practical answers to the question, "Where can Great Britain look for her supplies of Sulphur?" There are, of course, several smaller sources from which some assistance is obtainable—namely, the Zinc Concentrates of Australia, the smelting of which is to be a new industry in England for the production of Zinc, and arising therefrom will come a production of Sulphuric Acid supplementary to the operations hitherto performed for that purpose in this country.

It is also true that the United Kingdom itself contains small deposits of iron pyrites, but from the point of view of Sulphur the quality is so inferior that although it was thoroughly exploited during the recent War it cannot be said to be an economic answer to the problem, even to the trifling extent of 1 or 2 per cent. of our industrial requirements.

Canada possesses certain deposits of pyrites, and during the War appreciable assistance was secured thereby, but owing again to the comparatively inferior quality and to the consequent high cost as against the elementary Sulphur of the United States and Sicily, and the valuable deposits of Iron Ore in Spain, Canadian production in normal times cannot be regarded as other than a very slight assistance to the Sulphur buyers of the world.

Cyprus possesses a small, although useful, deposit of good quality pyrites, amounting only to some 3,000,000 to 4,000,000 tons, but this deposit is in American hands, and although reaching these shores in trifling quantities cannot be said to have a bearing on this nation's problem.

In conclusion, therefore, when industrial problems either of peace or war confront the United Kingdom, it must not be forgotten that Sulphur is a fundamental raw material of British Industry, and that Great Britain is at present dependent upon other countries for, approximately, 85 per cent. of the quantity that is essential to the conduct of her affairs

ROBERT GROSVENOR PERRY.

March, 1924.

AUTHORS' PREFACE

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H. G. T. BOORMAN.
A. W. ASHE.

LONDON,
March, 1924.

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CHEMICALS

PART I

CHAPTER I

INTRODUCTORY

THE chemical industry within the British Empire has undergone development in many directions since the year 1914, when the Empire found itself cut off from its main sources of supply in a great many manufactures and products vital to the successful conduct of war.

For many years Britain was so firmly established in the heavy chemical industry, represented by the alkalies, sulphuric acid, bleaching powder, etc., that her position in the world's markets for these chemicals became supreme. This achievement is the more noteworthy when it is remembered that Great Britain has few natural resources at home; she has no sulphur, no phosphate, no nitrate, no manganese, no bromine, no iodine—in other words, practically none of the elements necessary to chemical manufacture. Her natural resources are coal and salt, and on this foundation Britain, with her knowledge of finance, engineering, and chemistry, and her initiative, has been successful in building up her powerful chemical industry. Germany, her greatest potential rival, was, therefore, forced to seek some other field in which to develop her chemical manufactures, and, as the result of the expenditure of vast sums of money in experimental work, coupled with the broad outlook and the combined scientific and business ability of the men who directed her chemical affairs, she founded and gradually developed the vast dyestuff and fine chemical industry which is now world famous. This same fine chemical industry called for great quantities of heavy chemicals, and in some cases the standard products available were unsuitable as raw materials. Thus the need for oleum in the manufacture of synthetic indigo was responsible for the development in Germany of the contact process of sulphuric acid manufacture, while the dyestuff industry demanded the development of the tar distillation industry, and in the years before the War it is clear that England's supremacy in the heavy chemical industry was being seriously challenged.

In 1914 Britain declared war on Germany, and supplies of dyestuffs for her textile and leather trades, to say nothing of optical and chemical glass and a host of other essential materials, ceased abruptly; nor had she the knowledge or plant necessary to manufacture these materials herself. In the highly organized dyestuff industry of Germany, on the other hand, the War brought about a change over from peace-time products to explosives, and after the battle of the Marne

the plant which had previously manufactured dyes was converted to the manufacture of high explosives and poison gases, and the British Empire was forced, in the midst of the greatest crisis she had ever faced, to begin to manufacture products of which her enemy had had half a century's experience. With her back to the wall Britain staved off defeat, while her chemists and workmen established and developed high explosive and dyestuff factories capable of providing for her immediate needs and eventually for such supplies of material as enabled her to force Germany to her knees.

Modern warfare, apart from calling for enormous supplies of high explosives —and therefore of coal tar and chemical products for their manufacture— is also terribly destructive of every kind of wealth, and as the War went on the belligerent countries concentrated more and more on increasing their output of manufactured goods for their troops. Even with existing factories working night and day and new ones being started wherever possible, the demand continued to exceed the supply, and the few neutral countries joined in the race to catch up war's destruction.

Germany's submarine warfare, and the consequent shortage of merchant vessels, made transport very difficult, and therefore tended to make each country aim at manufacturing as many of its own needs as possible. Thus, in the dyestuff industry, and in others in which Germany was a chief producer, the position of all countries was the same as that of Britain, and supplies had to a large extent to be obtained locally or not at all.

At the close of the War it became possible to consider the needs of the civilian population, which for more than four years had been earning high wages with very little time to spend and only such small quantities of goods available for purchase as could be spared from the needs of the fighting forces.

The world, then, was crying out for goods, and trade entered upon a period of extreme activity, fostered by world-wide inflation of currencies and the lavish spending of war-time profits and gratuities. It did not seem possible to produce fast enough to meet the demand, and prices, assisted by speculation, inflation, low output, and high wages, rose by leaps and bounds to an extraordinary height.

This state of affairs went on for little more than a year and then, but with amazing suddenness, the inevitable happened—the greatest boom in the history of the world was followed by the worst slump ever known. All buying, apart from the barest necessities, ceased abruptly, and the country entered on the long period of unemployment and bad trade which, in the chemical industry, has endured with slight improvement until the present time.

In the nature of things the slump, as a world-wide state of affairs, could not continue indefinitely, but when demand began again to appear Germany's currency had so fallen in value that she could undersell any and all of her competitors, and did in fact get into her own hands a great deal of the chemical trade of the world.

The general war-time need of self-support that we have outlined above had operated in Germany as in the other countries, and had given a tremendous fillip to invention and enterprise, resulting—to name two instances only—in the improvement and increase of her " contact " plants for the manufacture of

sulphuric acid and her process for the fixation of nitrogen from the atmosphere, while the enormous expansion of her dyestuff industry had produced large quantities of heavy chemical by-products of a readily saleable nature. Germany, therefore, was in a position to supply almost every need of the chemical trade, and she made full use of her opportunity.

The problem now facing Britain is of a twofold character.

In the first place there is the enormously increased productive capacity of the world, due to the general war expansion of the industry indicated above, and, secondly, a general decrease in demand, the two together resulting in increased competition for such business as there is.

The problem is rendered still more complex by falling exchanges, tariff barriers, and high taxation, and added to the general falling away in demand there is the loss of Russia and of virtually the whole of Central Europe and the Near East as markets for our goods.

The purpose of this book is to give some account of the chemical needs and resources of the Empire and to make suggestions for the development of Imperial trade, but we cannot refrain from adding that in our opinion the first and most urgent step in this direction is not so much to develop existing and to find fresh resources as to rehabilitate by one means or another the export trade of this country. It is probable, however, that the development of hitherto untouched resources will assist the process, and we may consider this and other possibilities in a later part of the volume.

It would have been desirable to give some account of the Empire's total pre-war and post-war production and trade in the most important chemicals, but it must be realized that the statistical information available is poor in the extreme, particularly as to the United Kingdom production, since no official figures have been published since the census of production of 1907. We have therefore considered it advisable to make no attempt at the presentation of Empire statistics, but have devoted our attention in Part II. of this volume to a detailed survey of the trade, resources and needs of the various parts of the Empire, while in Part III. we will offer our conclusions from the facts previously outlined and such suggestions as we are able to make for the improvement of the situation.

It may be noted in passing that we have refrained from giving values as far as possible, as the fluctuations in the purchasing power of money during the last ten years have rendered any money comparisons very misleading.

We also think it well to draw attention to the difficulty in obtaining statistical information upon which we have already touched. The Customs classifications in this country, thanks to the efforts of the Federation of British Industries, have been considerably improved between the years 1913 and 1921, but they could be still further improved in many ways from the chemical point of view.

In the other countries of the Empire too many products are entered by value only, or are entered simply as "Chemicals," while the various specified products are grouped differently in almost every case. Quantities such as "bags," "packages," and "barrels" are also used, which convey no accurate information as to the amount of the article in question.

We quite realize that any basic alterations of the systems now in force would

probably not be warranted by the need for more ample information, but we cannot help thinking that it would be a useful and comparatively simple step in the right direction to adopt a more uniform classification throughout the Empire, to enter goods by weight wherever possible, and to separate out various products at present grouped.

NOTE.—Throughout this book the countries of Great Britain and Ireland have been referred to under their old title of "The United Kingdom." It would not be practicable nor convenient to treat Ireland separately in its new status as a self-governing Dominion.

CHAPTER II

INTRODUCTORY TO PART II

GROUPING OF PRODUCTS. GEOGRAPHICAL ARRANGEMENT.

IN the various chapters of this book we shall give statistics designed to show in as clear a manner as possible the trade of the Empire in the more important chemical products in the year immediately preceding the War as compared with the year 1921. We have taken the latter, as 1920 can under no circumstances be considered typical of post-war trade. We realize that 1921 is open to criticism in the opposite sense to the year 1920, in that trade was suffering from considerable depression during its currency. Nevertheless, it is felt that it was nearer to normal than either of the years 1919 or 1920. Furthermore, we have been unable to adopt 1922 for purposes of comparison, as complete statistics were not available for that period at the time the compilation of our statistics had to be begun.

In the following chapters the British Isles and the various British Possessions and Protectorates will be dealt with in detail, and statistics will be given for the years named above for purposes of comparison of pre-war and post-war trade. As far as the chemical industry is concerned Great Britain and, to a lesser extent, Canada are the only manufacturing countries of any considerable importance, and even Canada can scarcely be compared with Britain in this respect. Again, the chemical trade of certain British possessions, of which Hong Kong and the Straits Settlements may be taken as typical examples, is confined almost exclusively to re-export. Hong Kong in particular is a clearing house for our Chinese trade, and retains for home consumption only an inconsiderable percentage of her very considerable imports. India and Burma are of outstanding importance for their mineral and vegetable products, while at the other end of the scale, as regards size, Nauru and Ocean Islands are famous for their phosphate deposits.

The British Empire is so vast and comprises so many Dominions and Colonies that it has been found necessary, in order to facilitate dealing with the subject in hand in as clear and concise a manner as possible, to divide the Empire into

a number of well-defined geographical areas. The areas have been so arranged as to coincide as far as possible with the continents.

For the same reason the chemical products themselves, which broadly are of two classes—heavy and fine chemicals—have been divided for convenience of treatment very roughly into eight groups, which we have termed the alkali industry, general heavy chemicals, fertilizers, coal tar and its by-products, organic acids and salts, dyestuffs and intermediates, fine chemicals, drugs and medicinal chemicals. The first four groups cover the main heavy chemicals, and the last three groups the fine. It is difficult to say which is the most important of these groups at the present day, but certainly the industry of alkalies and their allied chemicals can claim to be the oldest. This industry has sprung up where there are supplies of coal, salt, and limestone; and in England the alkali industry is established in Lancashire, Cheshire, and on Tyneside. The salt deposits of Cheshire are sufficiently famous for it to be unnecessary to comment upon them in this volume, and other necessary raw materials are furnished by pyrites and by-product ammonia.

A curious feature of the development of the chemical industry in Britain has been the fact that some of our most important chemicals have originally been produced as objectionable waste products, which have become a nuisance, if not an actual danger to health, in the neighbourhood of the various works. In consequence, manufacturers in the past have been compelled to devise methods of dealing with these waste products, and in one or two cases the industry has actually come to be carried on for the sake of the by-product rather than the original product.

It may truly be said that one of the aims of modern chemical practice is to secure better efficiency in existing processes and to seek methods of utilizing hitherto waste products. The latter aim became a necessity during the War, when, for example, flue dust became a source of potash. More and more heat which formerly was allowed to be dissipated is in the modern works utilized to carry on other processes, such as the evaporation of mother-liquors and the heating of air for furnaces. The old wasteful processes, of which the beehive coke oven may be taken as a typical example, are now disappearing and the modern chemical industry is an example of intensive production with the minimum of waste.

The second group which we have mentioned above—namely, general heavy chemicals—depends to a large extent upon alkali products for its processes, as do also the majority of chemical processes in every branch of the industry, and perhaps this fact should entitle alkalies to the position of greatest importance.

On the other hand, the chemicals of the coal tar industry, with their myriad intermediates and derivatives, must also be considered to be amongst the most important. We rely upon them in almost every industry. Our railways are laid on creosoted sleepers; our telegraph systems are carried on creosoted poles; the roads in our cities are paved with tar blocks and in the country are constructed with tarred slag and macadam. Benzol is a very considerable factor in the supply of motor spirit. Toluol and carbolic acid are the bases of the most important high explosives. Our cotton, silk, woollen, and leather industries depend upon the dyestuffs produced from coal tar products. Our paint manufacturers use naphtha for their quick-drying preparations and anti-fouling compositions for

the shipbuilding industry. These represent only a few instances of the importance of this branch, and could be increased almost indefinitely, the manufacture of coal tar dyes themselves having become an industry of great importance.

This now brings us to our fourth group, dyestuffs and intermediates. These have been developed largely during and since the War. The passing of the Dyestuffs Act has been of considerable assistance to our colour manufacturers, in that it is now scarcely possible to buy a dye of foreign manufacture if it is able to be produced at a reasonable figure in this country. It may now be hoped that the industry is sufficiently well established to enable us, within a reasonable period, to compete in and retain a share of the world's markets without protective assistance, should this at any time be necessary.

The last two groups—namely, fine chemicals and drugs and medicinal chemicals—are also growing branches of the industry; and by developing inter-Imperial trade it is reasonable to suppose that we shall be able completely to satisfy the Empire's needs from internal sources.

In Part II. of this volume will be given a short account of the most important chemicals in the particular country under review. As previously mentioned, statistics for the years 1913 and 1921 will be shown, and in addition some account will be given of the chief markets to which any product is exported and also the chief industries which create the demand.

We shall also give some particulars of the usual channels of trade in the chief countries, and a short account of the natural raw material resources from the point of view of the chemical industry. It must be realized, however, that the basic raw materials of the chemical industry are almost without exception of a mineral character, and they will, therefore, come within the scope of other volumes* in this Series, to which the reader is referred for information of a fuller and more detailed nature than comes within the province of this book.

The parts of the Empire with which we are dealing will be grouped in the following manner:

EUROPE.—The United Kingdom—Gibraltar—Malta—Cyprus.

ASIA.—India and Burma—Ceylon—British Malaya—Hong Kong—Aden and Socotra.

AFRICA.—The Union of South Africa—The Gambia—Sierra Leone—The Gold Coast and Ashanti—Nigeria—Nyasaland—The South-West Africa Protectorate—The South African High Commission (Basutoland, Swaziland, and Bechuanaland)—Northern and Southern Rhodesia—The Kenya Colony and Protectorate—Somaliland—Mauritius and Dependencies—The Seychelles Islands—Zanzibar and Pemba—Egypt.

AMERICA.—Canada—Newfoundland and Labrador—British Honduras—Bermuda—The Bahamas—Jamaica and Dependencies (The Turks and Caicos Islands)—The Leeward Islands—The Windward Islands—Barbados—Trinidad and Tobago—British Guiana—The Falkland Islands.

AUSTRALASIA.—Australia and Tasmania—New Zealand—British New Guinea—Fiji—Nauru—Ocean Island

* See *Ferrous Metals*, *Non-Ferrous Metals*, and *Fuel*.

As we have stated above, the only chemical producing countries of considerable importance in the Empire are the United Kingdom and Canada, and we have thought it well to devote a good part of our space to as full an account as possible of the situation in these places. Australia, perhaps, with a considerable fertilizer industry, may take next position in order of importance, and India, too, is entitled to some consideration. The rest of the Empire, apart from the case of certain particular articles, is relatively unimportant from the production point of view, and will, therefore, be dealt with at less length.

In the statistics which follow we have endeavoured as far as possible to distinguish between home produced exports and re-exports, but it will be realized that considerations of space preclude our giving very detailed information as to sources and destinations.

PART II

SECTION I.—EUROPE

CHAPTER III

THE UNITED KINGDOM : GENERAL HEAVY CHEMICALS

§ 1.

In the past century it was truly said that the prosperity of England could be judged by the condition of the sulphuric acid and alkali industry. Even with the changed conditions in modern life, and in the alkali industry itself, that statement is probably as true to-day. Just as the animal organism depends to a considerable degree upon a supply of salt for its well-being, so does the industrial life of the nation depend, perhaps even to a greater extent, upon the same substance for its commercial health. Salt is, in fact, one of the corner-stones supporting the commercial prosperity of the country, coal being the actual foundation.

The fact that deposits of salt existed in Britain was known for some centuries, but from early times alkali had been obtained from the ash of certain plants, and it was not until late in the eighteenth century that the application of salt to the production of soda was first attempted. It was the increasing use of seaweeds for the production of soda that directed attention to salt as a possible source of alkali supply, and in 1775 the French Academy of Science offered a prize for a method of converting sodium chloride into soda, which prize was won by Leblanc. The French Revolution broke over Paris and prevented Leblanc from receiving the money offered, but later the National Assembly granted him a patent and he was able to equip a small factory and to work the process successfully for about three years. The factory was seized by the Republican authorities for the benefit of the State, and although, after disputes lasting nearly five years, Leblanc regained his factory, he had come to the end of his resources and, in despair and practically starving, committed suicide.

The Leblanc process consists in heating salt with sulphuric acid, by which sodium sulphate or saltcake and hydrochloric acid are produced. The latter substance, in the earlier stages of the industry, was allowed to pass into the air in the form of gas, until it became the subject of much complaint and costly litigation. After several years the condensing tower was invented and the alkali manufacturers were enabled to recover the valuable hydrochloric acid in liquid form. The second stage in the process is the calcining of the saltcake with excess of limestone and coal, by which black ash is obtained, and, subsequently, the extraction of the sodium carbonate by dissolving in water.

The development of the textile industry, requiring, as it does, great quantities of bleaching materials, was responsible for the provision of an outlet for the

hydrochloric acid waste produced in the first stage of the Leblanc process, and was largely responsible for the continuance of the Leblanc process itself. Not only did it provide an outlet for the acid fumes, but it actually converted a dangerous waste product into a valuable article of commerce. The hydrochloric acid was condensed as it left the saltcake roasters, and was then heated with manganese dioxide with the production of chlorine gas. The chlorine was absorbed by hydrated lime, and bleaching powder produced.

As we have mentioned in a previous chapter, the disposal of the black ash waste became a serious problem in that it accumulated in huge quantities in the neighbourhood of the alkali works, and, consisting mainly of calcium sulphide, gave rise to a serious menace to the health of the population in the surrounding districts, owing to the exhalation of sulphurous vapours into the atmosphere and the pollution of the rivers and streams. It is to Chance of Oldbury that we owe the discovery, in 1888, of the first really successful process for the recovery of the sulphur from black ash waste, and, like hydrochloric acid, this sulphur recovery assisted in prolonging the life of the Leblanc process against the opposing processes of alkali manufacture.

In the course of time a new process for the manufacture of alkali was discovered, and was the first threat to the permanency of the Leblanc system. It is known as the ammonia-soda or Solvay process, and on its first appearance bade fair to replace the Leblanc process entirely, since no objectionable waste products were produced and the cost of manufacture was much less. Briefly, it depends on the formation of sodium bicarbonate, when carbon dioxide is passed through a saturated solution of brine containing ammonia. The bicarbonate, being relatively insoluble, separates, and ammonium chloride is left in solution. The bicarbonate is heated to form the normal sodium carbonate, and the carbon dioxide is returned to the process. The ammonium chloride is then heated with lime, when calcium chloride and ammonia are produced, the ammonia also being returned to the process. Unfortunately, the chlorine is entirely wasted by this method of manufacture, since it is not possible to recover it economically from calcium chloride. It has been suggested that it might be replaced by magnesium chloride, but this material exists in the Stassfurt deposits so freely that it would not be possible to compete. The calcium chloride is, however, used in the manufacture of ice, this industry providing its chief market, but mention of other consuming industries will be made later.

With the increasing demand for chlorine for the manufacture of bleaching powder, and the valuable recovery of large quantities of sulphur from Leblanc waste products, a further lease of life was given to the Leblanc process, and it was carried on to about the same extent as the new Solvay process. In 1895 it is said that about 400,000 tons of salt were consumed by each process.

At a time when the British alkali manufacturers had established themselves in the markets of the world, and foreign countries depended upon them for the bulk of their supplies, some of our best customers introduced protective tariffs, which resulted in the development of the alkali industry in their own countries; competition became very keen, and the old and extravagant Leblanc process

received another great blow to its prestige. Finally, electrolytic processes made their appearance, and the production of caustic soda and chlorine direct from the brine sounded its death knell.

§ 2.

The heavy chemical industry is of such vast importance in Britain that we have considered worthy of the brief historical survey in the preceding section that branch of it which consists of the manufacture of alkalies. We have made no attempt to treat the matter in any other than a superficial manner, since it has already been the subject of many volumes; neither have we made mention of the numerous other chemicals which result from the utilization of alkali waste, nor of sulphuric acid, which is the second raw material necessary for the saltcake process.

Sulphuric acid has certainly been known since the late seventeenth century, when it was prepared in small quantities by heating green vitriol, but its production on a manufacturing scale was first commenced, in the middle of the eighteenth century, in lead chambers only a few feet square in which nitre and pyrites were burnt together. From this commencement the industry has developed to the enormous dimensions which it has attained to-day. Its manufacture in the past has been carried out almost exclusively by the lead chamber process, but this process, like so many others in the chemical and allied industries, has now to compete with the newer "contact" process, by which sulphuric acid can be produced in a more concentrated form than is possible by the "chamber" process. In principle, the contact process consists in the direct oxidation of sulphur dioxide to sulphur trioxide by the aid of a catalyst such as platinized asbestos.

During the War sulphuric acid was required in all belligerent countries in quantities that would have been deemed fantastic ten years ago, and in Germany the extension of the "contact" process was enormous. In Britain also large "contact" plants were erected, and a number are being operated at the present time. By the production of sulphuric acid by the "contact" process, all subsequent concentration is rendered unnecessary, and "fuming" sulphuric acid, and oleum containing high percentages of sulphuric anhydride, can be readily obtained. From this oleum any desired strength of acid may be had by mere dilution, the reverse of the costly method of concentrating chamber acid.

We have given a brief description of the production of the more important chemicals of the alkali and its allied industries—namely, soda ash, saltcake, caustic soda, sodium bicarbonate, hydrochloric acid, bleaching powder, and sulphuric acid. Numerous other chemicals are closely connected with the same processes, but must be dealt with later.

In speaking of the "alkali industry," it must be understood that its main products are essentially heavy chemicals, and are only classified under the alkali heading for convenience in dealing with so great a subject. In fact, it would be true to say that the chemicals we have named are the very basis of the whole heavy chemical industry. To render a complete list of the trades in which these materials are consumed would be almost an impossible task. Sulphuric acid

alone is used in the production of practically every manufactured article, or in the production of one or other of its raw materials. Some idea of the enormous amount produced may be gained from the following figures:

External Trade of the United Kingdom in Sulphuric Acid (Cwts.).

Origin or Destination.	*Imports.*		*Exports.*		*Re-Exports.*	
	1913.	1921.	1913.	1921.	1913.	1921.
Empire	Nil	Nil	100,058	49,655	5	No
Foreign countries	141,558	127	70,445	4,087	6	statistics
Total	141,558	127	170,503	53,742	11	—

It will be seen that the export of sulphuric acid, both to Empire markets (of which British India has usually been the most important) and to foreign countries, has fallen off enormously since 1913, although the Empire is still our largest buyer abroad. The export, however, is unimportant as compared with its consumption in the home markets.

The pre-war production of sulphuric acid in the United Kingdom has been estimated at about one million tons annually. The acid is consumed principally in the manufacture of superphosphate and sulphate of ammonia, each industry taking about 300,000 tons; it is used also in the production of bleaching powder, hydrochloric acid, alkali, and alum, these industries taking probably 200,000 tons. Sulphuric acid is further used for iron pickling; recovery of grease in textile trades; copper sulphate manufacture; dyeing; bleaching; dye-making; oil-refining; and explosives manufacture.

It is consumed in the explosives industry in the manufacture of nitroglycerine, guncotton, and T.N.T.; also in the manufacture of nitrocotton, a soluble nitro-cellulose which is one of the chief raw materials of celluloid. The dyestuff industry calls for certain quantities of sulphuric acid (possibly 30,000 tons a year) for use as a sulphonating agent and with nitric acid in nitration processes. In the coal tar trade it is employed for the washing of crude benzols and like materials, while its applications to the chemical industry in general are too widespread to be given in the limited space available here.

The manufacture of sulphuric acid is carried on chiefly in those districts where its distribution to the consuming industries is most easily effected. The explosives industry is the exception in this respect, not only as regards sulphuric acid, but in all its raw materials, as the factories are perforce erected as far from habitation as is conveniently possible. Broadly, it may be said that sulphuric acid factories are to be found wherever the heavy chemical industry is carried on.

Of the alkalies themselves, soda ash and caustic soda are the most important, and have so many applications in almost every industry that it is impossible to detail them all. The carbonate is sold both in the anhydrous and crystalline form, the latter being known as soda crystals. Soda ash is extensively used in soap-making, where it is converted to caustic soda by treatment with lime, chalk being precipitated. The resulting lye is used for the saponification process.

It is also used in the textile industry in connection with the bleaching process, in dyeing, in the treatment of leather, and in paper mills. In the manufacture of certain types of ordinary window or bottle glass soda ash is an essential raw material, although saltcake is more widely used. In many industries which involve an acid process, the materials are subsequently neutralized by boiling in soda ash solution. On account of its suitability as a flux it finds application in certain branches of metallurgy. Finally, there is a great demand for it in most other branches of the chemical industry, and more particularly in the production of other sodium compounds such as silicates, etc.

Sodium bicarbonate finds its chief application in the manufacture of such materials as baking powder and mineral waters, on account of the readiness with which it parts with carbon dioxide to form the normal carbonate. It also has its uses in soap and paper works, and to some extent in tanning and dyeing.

Soda crystals constitute the washing soda known to every housewife, and are chiefly used in domestic processes, such as cleansing, etc., in laundries.

Caustic soda is as important in its uses as the other chemicals of the alkali group. In soap-making it is used for the same purpose as the carbonate, but being already in the form of hydroxide renders unnecessary the treatment with lime. It is used extensively in bleaching and cleansing textiles and cotton wastes; the fabric to be treated is boiled with weak caustic soda solution, usually under pressure, in a " kier," and after this process is almost white. Another great consuming industry is that of the manufacture of dyestuffs and intermediates; by fusing sulphonic acids with caustic soda phenolic bodies are produced. The reclaiming of rubber from scrap waste also constitutes a market for caustic soda, the solution being employed to remove fibres. It is also used in the mercerizing of cotton.

Sodium sulphate or saltcake is produced in great quantities by the method which formed the initial stage of the Leblanc process, but does not command such a ready market as the alkalies themselves. It is, in fact, sometimes difficult to dispose of the amounts which accumulate, although it is exported in large quantities to Scandinavian countries which are engaged in the manufacture of wood pulp for the paper industry. By means of saltcake enormous quantities of wood pulp are produced by what is known as the sulphate process; but the sulphate is reduced to sulphide when igniting the evaporated liquor residues, and the foul gases produced tend to make the process unpopular. Being stable and not readily affected by atmospheric conditions, it is usually shipped in bulk.

Saltcake is employed in the heavy chemical industry for the manufacture of sodium sulphide, and in the textile trade in dyeing cotton and wool. As has been mentioned before, it is employed in considerable quantities in the manufacture of glass, and is also used for ice-making. In crystallized form sodium sulphate is known as Glauber salts, which are consumed in great quantities medicinally. It is also in the form of Glauber salts that sodium sulphate is used in the dyeing industry.

In order to show the firm stand that Britain has made and retains in foreign markets in alkalies and their allied chemicals, we present the following statistics:

EXTERNAL TRADE OF THE UNITED KINGDOM IN CERTAIN ALKALIES, ETC. (CWTS.).

Product.	*Origin or Destination.*	*Imports.* 1913.	*Imports.* 1921.	*Exports.* 1913.	*Exports.* 1921.	*Re-Exports.* 1913.	*Re-Exports.* 1921.
Sodium carbonate and bicarbonate in all forms	Empire	2,009	9,890	1,345,251	1,279,947	40	Nil
	Foreign countries	35,268	11,980	2,548,513	1,736,379	231	Nil
	Total ..	37,277	21,870	3,893,764	3,016,326	271	Nil
Sodium sulphate in all forms	Empire	No statistics	Nil	68,266	11,138	No statistics	Nil
	Foreign countries		4,530	1,256,633	401,488		Nil
	Total ..	—	4,530	1,324,899	412,626	—	Nil
Caustic soda	Empire	2,290	Nil	314,892	145,654	Nil	Nil
	Foreign countries	4,902	2,509	1,183,253	443,149	899	84
	Total ..	7,192	2,509	1,498,145	588,803	899	84
Bleaching powder	Empire	Nil	Nil	97,499	103,197	40	Nil
	Foreign countries	131,290	11,786	628,891	55,464	Nil	120
	Total ..	131,290	11,786	726,390	158,661	40	120
Hydrochloric acid	Empire	No statistics	Nil	2,940	1,620	No statistics	Nil
	Foreign countries		28	1,326	865		Nil
	Total ..	—	28	4,266	2,485	—	Nil

The figures for sodium sulphate include saltcake, and those for sodium carbonate include soda crystals, soda ash, and sodium bicarbonate.

Of what we have termed the alkali group, hydrochloric acid and bleaching powder remain. We have described the manner in which hydrochloric acid is obtained by the Leblanc process, but a few words on its application to industry are necessary. Its use in the manufacture of chlorine gas for the production of bleaching powder, which is its most important application, has also been described, and the reader will, no doubt, have realized its obvious utility in the manufacture of chlorides such as those of ammonium and the metals. It is consumed in very considerable quantities in the manufacture of glues, and also in the dyestuff industry for the purpose of producing hydrochlorides of basic intermediates and certain colours such as rosaniline hydrochloride, better known as magenta. Hydrochloric acid and chlorides are also known in the chemical trade as muriatic acid and muriates.

Bleaching powder or chloride of lime correctly named is calcium hypochlorite. In its manufacture chlorine gas is passed into leaden chambers containing dried slaked lime, and the resulting product will contain up to about 35 per cent. of

available chlorine, or even higher percentages. It derives its name from its wide use in the bleaching of cellulose fibre; on "souring" with an acid, nascent chlorine is liberated in the fibre and the colour is destroyed. On account of its strong oxidizing powers it is extensively employed as a disinfectant. It was to the use of chloride of lime in sterilizing the water supplied to our troops on active service during the War that we owe the extraordinarily low loss of life from disease. Another very interesting application of bleaching powder is in the manufacture of chloroform. There are numerous other uses to which it is put, but the above represent the main sources of demand.

Calcium chloride, which is produced as a by-product in the ammonia soda process, besides its use in the manufacture of ice, to which we have already referred, finds extensive application in other directions. The fused anhydrous salt is extremely hygroscopic, and if exposed to the atmosphere will absorb in a short time sufficient moisture to render it completely liquid. This property is utilized in a great many processes for the drying of liquids and gases. It has been employed in great quantities for the drying of furnace gases where this is necessary. It is used also for the preparation of certain calcium salts of acids, from which sodium salts may be readily obtained by the addition of either sodium carbonate or sulphate, the calcium being precipitated in the form of carbonate or sulphate as the case may be. An example of this use is seen in the manufacture of tartaric acid. Calcium chloride has numerous other uses commercially, such as in the brewing trade, the manufacture of starch, and in the textile and paper trades, to name only a few.

With the exception of sulphuric acid the heavy chemicals with which we have dealt in this section are manufactured mainly in those districts where salt is obtainable. It is true that alkali works are situated in other parts of the country also, but only to a much smaller extent. The manufacture of bleaching powder necessarily is carried on in the same districts, depending as it does on the supply of chlorine produced directly from the electrolytic manufacture of caustic soda, or indirectly, to a smaller extent, from the saltcake process.

§ 3.

In § 2 we have endeavoured to sketch the magnitude of the alkali industry, and to give some slight idea of the almost limitless demands which other industries make upon its products. There are upwards of forty other heavy chemicals which are worthy of mention in this volume, and the grouping of them in a strictly methodical manner is impossible on account of their diversity in use and manufacture. We can only group them in as far as we are able with the minimum of confusion. We now propose to give a short account of some other important sodium compounds, such as silicate of soda and borax. The enormous volume of our trade in alkalies has been shown by the statistics given in the preceding section, and it will therefore be of interest to show that in other sodium compounds the trade of the United Kingdom is equally important.

External Trade of the United Kingdom in Certain Sodium and Other Products (Cwts.).

Product.	Source or Destination.	Imports. 1913.	Imports. 1921.	Exports. 1913.	Exports. 1921.	Re-Exports. 1913.	Re-Exports. 1921.
Sodium silicate	Empire	No statistics	5	No statistics	76,950	No statistics	Nil
	Foreign countries		696		195,080		100
	Total ..	—	701	—	272,030	—	100
Cyanides of sodium and potassium	Empire	No statistics	Nil	90,909	83,774	No statistics	20
	Foreign countries		1,174	49,563	24,769		6
	Total ..	—	1,174	140,472	108,543	—	26
Borax	Empire	Nil	Nil	No statistics	21,105	Nil	37
	Foreign countries	16,940	15,083		85,602	223	1,002
	Total ..	16,940	15,083	—	106,707	223	1,039
Other sodium compounds	Empire	Nil	Nil	97,967	46,412	528	226
	Foreign countries	135,332	101,375	403,560	63,344	1,068	308
	Total ..	135,332	101,375	501,527	109,756	1,596	534
Boric acid	Empire	No statistics	Nil	No statistics	13,640	No statistics	480
	Foreign countries		25,860		10,240		2,680
	Total ..	—	25,860	—	23,880	—	3,160
Sulphur	Empire	Nil	2,616	No statistics	19,727	5,574	2,960
	Foreign countries	364,283	306,203		6,024	8,823	7,160
	Total ..	364,283	308,819	—	25,751	14,397	10,120

Sodium silicate is a material of great value in several of our leading industries It is manufactured by the simple process of fusing sand with soda ash, or sometime with saltcake and carbon. It is sold in the form of a thick solution usually know as water glass.

It is extensively employed in the preparation of water paints and in the fire proofing of materials. Its solution in water is strongly alkaline, and on this accoun it finds application in dyeing. Sodium silicate is valuable as a special cement fo glass and similar materials. Its utility in preserving eggs is also well know Considerable quantities of it are consumed in soap manufacture, partly becaus of its detergent properties and partly as a filling. Its use in the paper industr lies in the property of giving a toughened finish to the paper.

Borax occurs in nature in Tibet and other countries on the Indian borders but it is chiefly obtained from minerals consisting of sodium and calcium borates or merely by the neutralization of boric acid by soda. Borax, well known fo its water-softening and cleansing properties, finds extended industrial uses

In solution it acts as a very mild antiseptic, and is employed medicinally in small quantities. One of the more important uses of fused borax is for making glazes in the pottery industry, while it is also employed to some extent in glass and enamel making. It is used in the process of brazing metals.

Boric or boracic acid of commerce is manufactured from boron minerals in the United Kingdom in considerable quantity. A smaller amount is made from imported crude boric acid, the bulk of our purchases coming from Italy, which country possesses natural resources of this crude material. The greater bulk of the boric acid sold in the United Kingdom is consumed for medicinal purposes and in the preparation of boracic lint. It is permitted by statutory regulation to be used as a food preservative within certain limitations, and it is also used in glass manufacture as a constituent of heat-resisting glasses.

Cyanides of potassium and sodium are produced in great quantities in the United Kingdom. The export statistics for 1913 include the sodium and potassium salts under one heading, but between that year and 1921 a difference in classification has been made, and it would appear that cyanides are chiefly exported as the sodium salt.

The most important use of cyanides is in the extraction of gold from the ores, on account of their capability of dissolving gold; this fact is clearly indicated by the export returns, which show that, in 1913, 27,765 hundredweights were shipped to the Transvaal and 33,348 hundredweights to Australia out of a total of 90,909 hundredweights to British Possessions; whilst in 1921 the same two countries and Canada were our best customers. Cyanides also find application in the electro-plating of metals.

Besides the compounds of sodium with which we have dealt separately, it is interesting to note that our exports in other sodium compounds, which are "lumped" in the statistics, amounted to over 500,000 hundredweights in 1913, and to over 100,000 hundredweights in 1921. It should be noted, however, that the 1913 figures include those for sodium silicate. As regards our exports to foreign countries, the greater proportion was shipped to European countries, Italy alone accounting for nearly 57,000 hundredweights in 1913, whilst the South American republics are also important customers.

Sulphur is the last material to be dealt with in this group. We are dependent upon imported sulphur with the exception of that obtained from gas works. The sulphur which is recovered from alkali waste may be looked upon as domestic, but it originated from the imported sulphur or pyrites from which the sulphuric acid was produced. In 1913, Britain exported something over 14,000 hundredweights of sulphur manufactured abroad. Sulphur is used in the manufacture of sulphuric acid, which accounts for the consumption of a considerable and growing quantity. Its application to the chemical industry as a whole is very wide, and it will not be possible to give much detail here. It is a constituent of ordinary black gunpowder, and is employed also in great quantities in the vulcanization of rubber. In agriculture it is used as a preventative of mould in hop-growing, and in medicine for the preparation of ointments and for internal use. In its compound sodium sulphide it is used in the dyeing industry and for the manufacture of dyes. In the same form it is used for removing hair from hides in the leather trade.

Sodium nitrate also falls into this group, but it will be remembered that this chemical is, in fact, almost wholly imported from Chile, and, as its consumption is chiefly as a fertilizer, it will be discussed in another section. Chemically, its chief use is in the manufacture of nitric acid.

Concerning the distribution of the chemicals in this section, the sale of borax and boric acid is largely in the hands of Borax Consolidated, Ltd., who work their own deposits of raw material, but certain quantities of borax are available from the lake brines of California worked by the Trona Corporation of America and others. The sale of sulphur is controlled by the American and Sicilian suppliers, who conduct their sales through certain representatives in England.

§ 4.

In this group we have placed compounds of the heavy metals, import and export statistics being available for red and orange lead, white lead, zinc oxide, and barytes. We have included these four compounds in one group on account of their association with the paint industry. It will be seen from the table which follows that the import and export figures evidence the huge trade which is carried on in the compounds under discussion. Taking the group as a whole, the United Kingdom is a considerable producer, but in spite of the fact that a great export trade is done, this country is nevertheless an importer rather than an exporter.

The exports of red and orange lead in 1922 were double those in the preceding year; about equal quantities were shipped to foreign countries and the Dominions. With regard to foreign countries, the Netherlands were the largest purchasers, accounting for 8,947 hundredweights out of a total of 25,592 hundredweights in 1921, and 21,440 hundredweights out of 67,769 hundredweights in 1922.

External Trade of the United Kingdom in Red and Orange Lead, etc. (Cwts.).

Product.	*Source or Destination.*	*Imports.* 1913.	1921.	*Exports.* 1913.	1921.	*Re-Exports.* 1913.	1921.
Red and orange lead	Empire	26	Nil	No statistics	26,170	2	Nil
	Foreign countries	60,980	21,293		25,592	554	116
	Total ..	61,006	21,293	—	51,762	556	116
White lead	Empire	Nil	10,714	278,575	92,538	21	Nil
	Foreign countries	321,323	61,584	89,279	31,095	421	3,042
	Total ..	321,323	72,298	367,854	123,633	442	3,042
Barytes (ground)	Empire	Nil	Nil	11,161	3,721	853	42
	Foreign countries	1,092,645	294,467	103,570	5,556	233	221
	Total ..	1,092,645	294,467	114,731	9,277	1,086	263
Zinc oxide	Empire	240	100	20,520	7,620	1,920	960
	Foreign countries	368,660	89,680	29,280	7,180	2,440	200
	Total ..	368,900	89,780	49,800	14,800	4,360	1,160

The exports of red lead are fairly evenly distributed, but Scandinavian countries are certainly second to the Netherlands in their individual consumption. Of the Dominions India accounts for the greatest quantity, when considering her imports over a number of years, although in 1921 Australian imports actually exceeded those of India; Australia is the next largest buyer, and imported in the years 1920 to 1922, 5,529 hundredweights, 8,304 hundredweights, and 7,205 hundredweights respectively. Hong Kong is also an importer of considerable quantities.

Red lead, or minium, is an oxide of lead and is prepared industrially by the careful heating of lead monoxide or massicot. It is chiefly used as a pigment, but is also employed in the manufacture of flint glass.

White lead, or basic lead carbonate, is manufactured by the action of dilute acetic acid or ordinary vinegar on metallic lead. By the Dutch process strips of lead are rolled into spirals in earthenware pots which are filled with vinegar and surrounded by dung or other suitable material. This generates heat and evolves carbon dioxide. Lead acetate is first formed, and this is decomposed by the action of the gas to form the hydrated carbonate.

In 1913 Britain imported 321,323 hundredweights of white lead, nearly 140,000 hundredweights coming from Germany. Belgium and the United States also supplied over 80,000 hundredweights each, none being imported from British Dominions. From 1919 onwards, however, Canada has become a supplier of considerable quantities. In 1921 and 1922 she exported to England over 10,000 hundredweights yearly. In recent years the bulk of our imports has come from the United States and Belgium.

Before the War exports of white lead exceeded imports by about 25,000 hundredweights, but from 1919 onwards, with the exception of 1921, our imports have exceeded our exports. Exports to foreign countries, although considerable, are much less than to British Dominions. In 1913, for instance, India imported from us 31,000 hundredweights, and Australia 138,000 hundredweights out of a total of 278,575 hundredweights. Exports in white lead have by no means recovered their pre-war dimensions, although in 1922 they had risen to 197,433 hundredweights. New Zealand is also an importer of very large quantities, the actual figures being 45,532 hundredweights in 1913 and 25,822 hundredweights in 1921, while in the same years the Union of South Africa purchased over 30,000 and 15,000 hundredweights. White lead is employed almost exclusively in the manufacture of paints.

This brings us now to Barytes. This substance, which in mineral form is crude barium sulphate, when prepared artificially by the precipitation of pure barium sulphate, is known as permanent white or blanc fixé. As a pigment the artificial sulphate is much preferred to the ground mineral sulphate, as it has a very much greater covering power.

The United Kingdom is an importer of very great quantities of barytes and blanc fixé, all of these imports coming from foreign countries. In 1913, 1,092,645 hundredweights were imported into this country, chiefly from Germany, although Belgium and Spain must always rank as large suppliers of the mineral in the years following the War. Germany actually exported to England, in 1913, 805,559 hundredweights, and in 1921, 203,580 hundredweights, while Belgian exports

to this country were 218,350 and 52,135 hundredweights in these years. In the four years 1919 to 1922 Spain exported to the United Kingdom 177,136, 103,978, 28,046, and 25,839 hundredweights respectively.

Turning now to exports, we find that our export trade in barytes has suffered very heavily since the War, and not until 1922 was there any sign of revival, the quantities in that year having amounted to 65,658 hundredweights as compared with 9,277 hundredweights in 1921. Exports to the Dominions are not sufficiently large to be worthy of very detailed account. In the official statistics the destinations are not classified.

Barytes, like the other compounds in this group, is mainly employed in the manufacture of paint. It is also precipitated with zinc sulphide to form a body known as lithopone, which is used as a pigment. Barytes finds application to some extent in the paper trade, where it is employed to give weight to paper, cards, etc.

Zinc Oxide is the fourth and last compound in the group with which we are dealing. It is manufactured by various processes, most of which depend on burning zinc and allowing the oxide to be deposited. It is known industrially as zinc white. A number of plants for the manufacture of zinc oxide was erected during the War, and at the Armistice the capacity of British works was sufficient to supply the home demand and leave a surplus for export.

Here, again, it will be found that the United Kingdom is an importer of zinc oxide. In the foregoing table it is shown that, in 1913, 18,445 tons were imported into this country, and of this quantity 6,834 tons were imported from Germany, 5,826 tons from the United States, and 4,973 tons from Belgium and the Netherlands.

In 1921, however, the total imports fell to 4,489 tons, of which 2,898 tons were from Belgian ports, while imports from Germany and the United States had fallen to 991 and 156 tons respectively.

In so far as exports are concerned, in 1913 our best foreign customers were France, Turkey, and the South American republics, Chile importing 339 tons of British manufactured zinc oxide. Of the Dominions, Canada is the largest and most consistent market, her imports for 1913 being 406 tons and for 1921 283 tons. We also exported quite considerable quantities to British India.

Zinc white, as the name implies, is chiefly of importance as a pigment. It is also largely used in the rubber trade, and is employed in the manufacture of cement and china. It also has valuable medicinal properties.

Besides zinc oxide there are many other valuable zinc compounds. The chloride, for instance, is used in great quantities in some countries as a substitute for creosote in the preservation of timber. Zinc salts are used also for mordanting fabrics in the dyeing trade.

§ 5.

We propose in this section to discuss briefly the following chemicals:

Calcium carbide.	Aluminium sulphate and alums.
Nickel oxide.	Arsenic compounds.
Cobalt oxide.	Phosphorus.
Copper sulphate.	Magnesium compounds.
Aluminium oxide.	

As we have pointed out previously, the grouping of chemicals in this chapter on any strictly logical basis cannot be attempted, and the materials we are about to describe are grouped thus for convenience only. It will be seen from the statistics which follow that the trade returns are not given in detail for any particular salt of magnesium, and only for very few of the salts of other metals in question. In the case of aluminium, for instance, alumina is given separately, but aluminium sulphate includes potash and ammonia alums. The value of the statistics, then, is not very great, but they serve to illustrate our import and export trade in a broad sense.

Taking first Magnesium Compounds, it will be seen that our exports for 1921 amounted only to 2,709 tons, while our imports for the same year were 12,919 tons. Magnesium occurs in very great quantities in the Stassfurt deposits, and it is not surprising to find that of our imports 10,217 tons were supplied by Germany. As regards exports to foreign countries, France was our best customer, and India the largest buyer amongst the Dominions; each country imported from Britain about 600 tons, Spain and Australia being the next largest importers with about 275 tons each.

Of magnesium salts, the chloride and sulphate are the most important, the carbonate also being entitled to consideration. It is in the forms of chloride and sulphate that magnesium salts exist mostly in the Stassfurt deposits. Magnesium chloride is used in sizing cotton, and also in the paper and textile trades. Another application of importance lies in the manufacture from magnesia and magnesium chloride of "sorel," or oxychloride cements, such as are employed in making artificial flooring, etc.

Magnesium sulphate is well known as the Epsom salts of commerce, in which form it is consumed in considerable quantities for medicinal purposes. Industrially it is employed as a weak sizing in cotton-spinning.

EXTERNAL TRADE OF THE UNITED KINGDOM IN MAGNESIUM COMPOUNDS (CWTS.).

Product.	*Source or Destination.*	*Imports.* 1913.	*Imports.* 1921.	*Exports.* 1913.	*Exports.* 1921.	*Re-Exports.* 1913.	*Re-Exports.* 1921.
Magnesium compounds, including chloride and sulphate	Empire	No statistics	Nil	No statistics	27,440	No statistics	300
	Foreign countries		258,380		26,740		Nil
	Total ..	—	258,380	—	54,180	—	300

Calcium Carbide.—This substance is consumed in enormous quantities in the United Kingdom, which imports practically the whole of her requirements chiefly from foreign countries. In the years 1919 and 1920 she imported 202,903 and 25,332 hundredweights from Canada, but none from that country in 1913 or after 1920. This is a clear instance of where inter-Imperial trade might be very much developed. Exports from this country amounted only to 1,899 hundredweights in 1913, and 5,851 hundredweights in 1921, while our imports for the same years amounted to 513,797 and 484,587 hundredweights respectively.

External Trade of the United Kingdom in Calcium Carbide (Cwts.).

Product.	*Source or Destination.*	*Imports.* 1913.	1921.	*Exports.* 1913.	1921.	*Re-Exports.* 1913.	1921.
Calcium carbide	Empire	Nil	Nil	1,432	5,258	1,208	620
	Foreign countries ..	513,797	484,587	467	593	277	49
	Total ..	513,797	484,587	1,899	5,851	1,485	669

Our imports in 1913 were mainly from Norway, Italy, and Sweden, the quantities being about 263,000, 147,388, and 96,263 hundredweights respectively. In 1921, however, our imports from Norway increased to 268,000 hundredweights, and from Sweden to 68,000 hundredweights, while Italy appears to have ceased operations as a supplier to the United Kingdom, at any rate for the present. The supplies which came from Italy in 1913 were substituted by imports from the Netherlands, Switzerland, and Czecho-Slovakia in 1921, each of these countries supplying over 30,000 hundredweights.

The uses of calcium carbide are so well known, particularly as a source of acetylene gas, that it will not be necessary to give them here in detail; it is, however, worthy of mention that by far the greatest quantity of carbide is consumed in the process known as acetylene welding.

Below will be seen statistics showing the import and export of nickel and cobalt oxides and of copper sulphate, the latter compound being of by far the greatest importance:

External Trade of the United Kingdom in Copper Sulphate, etc. (Cwts.).

Product.	*Source or Destination.*	*Imports.* 1913.	1921.	*Exports.* 1913.	1921.	*Re-Exports.* 1913.	1921.
Copper sulphate	Empire	No statistics	Nil	41,020	14,140	No statistics	20
	Foreign countries		240	1,471,640	545,800		Nil
	Total ..	—	240	1,512,660	559,940	—	20
Cobalt oxide	Empire	No statistics	Nil	No statistics	27	No statistics	1
	Foreign countries		72		292		25
	Total ..	—	72	—	319	—	26
Nickel oxide	Empire	Nil	12,544	No statistics	Nil	Nil	Nil
	Foreign countries	17,965	89		37	Nil	32
	Total ..	17,965	12,633	—	37	Nil	32

Nickel and cobalt oxides are of importance in the ceramic and enamelling industries. Both the oxides are made here, and Britain also imports nickel oxide from Canada, where it is produced in quantity in smelting the nickel cobalt ores of Ontario.

Our exports of cobalt oxide reached a total of 319 hundredweights in 1921, a

figure which was less than half of the exports for 1920 and less than one-third of the 1922 total. The principal salts of cobalt in common use are, however, such compounds as the sulphate, acetate, hydrate, nitrate, chloride, carbonate, aluminate, silicate, resinate, and oleate.

Chloride as a solution is sometimes used instead of oxide as a body stain for china clay in order to eliminate the cost of grinding and the risk of blue specking from the use of insufficiently ground oxide. For colouring pottery ware silicate is used to give Smalts blue, an intense violet-blue colour, while aluminate is used for Thènards or matte blue, a rich turquoise; and chloride, being volatile, is used in producing Flow Blue.

Acetate, resinate, and oleate of cobalt are all used as driers in the manufacture of paint. The drying of an oil depends on the rate of oxidation, which is enhanced by the use of cobalt salts as catalysts; by this means, in fact, the time required for drying is often reduced by as much as two-thirds. The salts are also used in enamels to produce shades of colour ranging from black through all degrees of blue to pure white.

Practically speaking there is no import of copper sulphate into the United Kingdom, nor do we re-export it. It is manufactured in Britain in great quantities, and, as will be seen from the foregoing table, we have a large exportable surplus. The demand arising for copper sulphate in the home market is not very great, since it is chiefly consumed in treating grape vines which are not native to this soil. Our exports to the Dominions, although amounting to 2,361 tons in 1922, are, nevertheless, small in comparison with our exports to foreign countries. In 1913 the United Kingdom exported to France 21,767 tons, and to Italy 27,128 tons. The exports to Italy have apparently not been maintained since the War, and in 1921 reached only the total of 537 tons. France, with her vast wine industry, is undoubtedly our best customer, and consistently imports from Britain over 10,000 tons annually. Of other countries, Portugal, Rumania, and Greece are important buyers.

Copper sulphate is produced for commercial purposes in the form of crystals, sometimes called copper vitriol or "blue stone," and as powder, known in certain markets as "neige" or "snow." Its principal use is that of preventing the growth and spread of certain kinds of fungi on living plants, fungi which are highly destructive in particular to the vine and potato, and in a lesser degree to tomatoes, pears, and apples. The copper sulphate is dissolved in water, and the acid solution thus produced is neutralized by the addition of lime or soda. These made-up solutions, known respectively as Bordeaux and Burgundy mixture, are then sprayed upon the plants, and by this means many million pounds worth of grapes, other fruits, and potatoes are saved annually from destruction. In its acid state the solution is used to disinfect wheat before sowing, to eradicate pernicious weeds, and to prevent rot in timber. It is also used as a sheep-scab dip, and as a disinfectant in cow-sheds. In the form of telegraph crystals it is employed in the making up of electric cells. Among other applications copper sulphate is used in the calico-printing industry and in the paint trade; also in the preparation of toning baths for photographs.

This brings us now to Alumina and Sulphate of Alumina. It will be seen from

the following table that our total imports in 1921 amounted only to 116 tons, which, with the exception of 1 ton, all came from Norway. In 1920 our exports amounted to 6,907 tons, almost all of which went to Norway, and in 1922 our export had again increased to 3,548 tons after its decline in 1921.

EXTERNAL TRADE OF THE UNITED KINGDOM IN ALUMINIUM OXIDE AND SULPHATE (CWTS.).

Product.	*Source or Destination.*	*Imports.* 1913.	*Imports.* 1921.	*Exports.* 1913.	*Exports.* 1921.	*Re-Exports.* 1913.	*Re-Exports.* 1921.
Aluminium oxide	Empire	No statistics	Nil	No statistics	40	No statistics	Nil
	Foreign countries		2,320		8,100		Nil
	Total ..	—	2,320	—	8,140	—	Nil
Aluminium sulphate	Empire	No statistics	11,600	233,380	134,480	No statistics	Nil
	Foreign countries		61,180	122,980	70,120		220
	Total ..	—	72,780	356,360	204,600	—	220

The hydrated oxide is of more importance chemically than alumina, since it is extensively used as a mordant in dyeing. It is also used in the waterproofing of fabrics, in the pores of which it is precipitated in the form of a gelatinous film which finally dries and becomes impervious to water.

Aluminium sulphate and alums are an important branch of the chemical industry in Britain, and are of Empire importance, since about half our exports are to the Dominions. During the years 1913 to 1922 the Argentine Republic was our principal foreign customer, having imported 1,000 tons in 1913 and over 1,800 tons in 1921. The greatest individual buyer of sulphate of aluminium is British India, which imported 5,835 tons in 1913 and 3,826 tons in 1921. During the Protectorate Egypt also purchased large quantities of alums from this country, Canada and Australia also buying fair quantities.

Turning now to imports, these amounted only to 3,639 tons in all during 1921, and were mainly from Germany. It is probable that the foreign material was bought at a low price in competition with that produced in Britain.

Aluminium sulphate is a most important chemical, having wide application in industry. In the first place, it has the property of forming double salts with other metals, of which salts potash alum, and ammonia alum are the best known, and it is used extensively in their manufacture. In application, sulphate of alumina is usually required in a condition of considerable purity, and it is therefore prepared from pure sulphuric acid and pure aluminium hydroxide, on account of the difficulty of attaining purity by other methods.

Aluminium sulphate is used in the dyeing and leather trades. It is extensively employed in the purification of water by filtration, and also in the paper industry to prevent the ink from spreading over the surface of the paper.

Potash alum, or common alum, is the double sulphate of potassium and aluminium. Like sulphate of alumina, it is an important compound, and is extensively used in much the same trades. In addition, it is used medicinally, in the confectionery trade, and also in the treatment of hides.

The two last products for which the customs figures are obtainable in this group are arsenic compounds, including white arsenic, and phosphorus. Below is the table of statistics:

EXTERNAL TRADE OF THE UNITED KINGDOM IN ARSENIC COMPOUNDS AND PHOSPHORUS (CWTS.).

Product.	*Source or Destination.*	*Imports.*		*Exports.*		*Re-Exports.*	
		1913.	1921.	1913.	1921.	1913.	1921.
Arsenic compounds	Empire	No statistics	4,140	1,460	600	No statistics	1,460
	Foreign countries		20,700	12,060	2,540		800
	Total ..	—	24,840	13,520	3,140	—	2,260
Phosphorus	Empire	No statistics	6,543	No statistics	520	No statistics	Nil
	Foreign countries		50		2,409		28
	Total ..	—	6,593	—	2,929	—	28

Of our imports of phosphorus in 1921, 6,543 hundredweights came from British Possessions, although the actual Dominions are not specified. In the preceding year we imported 12,834 hundredweights from our Dominions, and in 1922 15,846 hundredweights out of a total of 16,337 hundredweights. Our export, on the other hand, amounted only to 5,667 hundredweights in 1920, 2,929 hundredweights in 1921, and 3,102 hundredweights in 1922, of which the Dominions bought 492 hundredweights in 1920, 520 hundredweights in 1921, and 1,024 hundredweights in 1922. Our best foreign customer is Sweden. Japan also made considerable purchases from us in 1920 and 1921—1,332 and 686 hundredweights —but in 1922 our exports to that country had fallen to 18 hundred weights.

Phosphorus occurs in three modifications, of which two only are important —namely, the yellow and red, or amorphous, phosphorus. It is manufactured in considerable quantities in this country, and its use is almost entirely confined to the making of matches. Yellow phosphorus is extremely poisonous, a dose of 0·1 gram being fatal. For this reason, and because it takes fire spontaneously when exposed to air, it has largely been superseded by the red modification in industrial processes. Red phosphorus is not poisonous, and, moreover, is unaffected by exposure to air. Formerly, match heads were coated with a phosphorus preparation, but now the phosphorus is almost exclusively applied to the striking paper.

Of Arsenic Compounds, white arsenic is the most important. White arsenic is chiefly obtained by the roasting of ores containing arsenical pyrites, and is condensed in special chambers. To obtain it in its pure form it is sometimes necessary to resublime once or twice. It is extensively employed in the manufacture of arsenical sheep-dips, and as a general insecticide and weed killer. Calcium arsenate has come into prominence in the fight against the boll weevil, which is causing so much damage to American cotton crops. In dyeing it is used as a mordant, and is also consumed in the manufacture of glass. Another trade causing demand is that of the manufacture of pigments such as are employed in colouring paper, etc., of which Paris green may be taken as a typical example.

Turning to the trade of the United Kingdom in arsenic compounds, we find that in the year 1921 imports exceeded exports to the extent of over 20,000 hundredweights. White arsenic represents the bulk of these imports, the quantity actually being 24,040 hundredweights. The imports from foreign countries were 19,900 hundredweights, Greece being responsible for 11,900 hundredweights out of this total. Over the three years 1920 to 1922 our biggest suppliers in order of magnitude were Greece, Portugal, and the United States. Our total import of white arsenic from Imperial sources was 4,140 hundredweights in 1921, and Australia was responsible for practically the whole of it. Since Australia is apparently capable of supplying us with between 200 and 300 tons yearly, it seems regrettable that our whole imports cannot be supplied from the same source.

With reference to exports, only 71 tons of white arsenic in all were exported from the United Kingdom in 1921, and 86 tons of other arsenic compounds. The greater proportion of these exports was to foreign countries. As far as white arsenic is concerned, our export in 1920 was 618 tons, which fell in 1921 to the figure given above—namely, 71 tons. We are pleased to see, however, that trade had revived in 1922, and our export of white arsenic had increased to 203 tons.

§ 6.

We now propose to deal with certain organic acids and their salts, of importance in various branches of industry. It will also be convenient at the same time to describe the more important of the salts of these acids, since in the greater number of cases the official statistics do not differentiate between the acid and its salts. In this group are included acetic, citric, oxalic, and tartaric acids, together with certain important salts such as sodium and calcium acetates, cream of tartar, etc.

Acetic acid, as is generally known, is the acid principle of vinegar, and is obtained commercially by direct synthesis from acetylene and in the wood distillation industry. Synthetic production has made great strides in recent years in America, Canada, and on the Continent, and synthetic acetic anhydride was made in the United Kingdom during the War from home manufactured calcium carbide. Indeed, synthetic acetic acid is largely replacing non-synthetic acid on account of its lower price.

In the older method of manufacture the crude wood distillate is treated with calcium hydroxide, by which means calcium acetate is formed; the liquor is evaporated, and finally the crude grey acetate of lime is distilled with sulphuric acid, and glacial and other strengths of acetic acid are obtained.

Acetic acid is consumed in great quantities in Britain in a variety of trades. Immense amounts are used in the manufacture of synthetic indigo, and other synthetic organic products, such as cellulose acetate, used largely in the manufacture of artificial silk. Acetic acid is employed also in the dyeing industry and in calico-printing, while a certain amount is used by vinegar makers in place of the fermentation acid constituting genuine vinegar. In the form of various acetates it finds extensive use as a mordant in dyeing processes; it is, in fact, especially

suitable for this purpose, since, during the process, acetic acid is liberated from the salt and is volatilized, the metallic oxide remaining fixed in the fabric.

Of the acetates themselves the lime salt is the most important, since glacial acetic acid is obtained from it by distillation with sulphuric acid, and acetone by the dry distillation of the salt itself. Calcium acetate is one of those salts of acetic acid referred to above in use as a mordant in dyeing.

EXTERNAL TRADE OF THE UNITED KINGDOM IN CERTAIN ACIDS AND ACETATE OF LIME (CWTS.).

Product.	*Source or Destination.*	*Imports.* 1913.	*Imports.* 1921.	*Exports.* 1913.	*Exports.* 1921.	*Re-Exports.* 1913.	*Re-Exports.* 1921.
Acetic acid	Empire	Nil	Nil	No statistics	480	Nil	40
	Foreign countries	75,120	38,800		680	Nil	660
	Total ..	75,120	38,800	—	1,160	Nil	700
Citric acid	Empire	No statistics	21	No statistics	2,172	No statistics	54
	Foreign countries		2,604		2,571		1,164
	Total ..	—	2,625	—	4,743	—	1,218
Acetate of lime	Empire	62,329	Nil	No statistics	81	Nil	Nil
	Foreign countries	37,253	4,458		Nil	400	Nil
	Total ..	99,582	4,458	—	81	400	Nil

Above are the figures showing imports and exports of acetic and citric acids and acetate of lime, from which it will be seen that Britain buys large quantities particularly of acetic acid.

Citric acid is, perhaps, the least important of those acids of which we are writing in this group, but it is of interest to note that its manufacture has been undertaken in the British West Indies. It is, of course, made in the United Kingdom in quantity with a margin for export. It occurs in the juice of lemons and limes, these constituting the main source of supply. It is obtained from the juice as citrate of lime by the addition of chalk, the citrate being later decomposed by mineral acid and the citric acid thus obtained crystallized. It is used in the confectionery and mineral water trades, and to some extent also in medicinal preparations. Calico-printing is another industry which creates a demand for citric acid.

Oxalic acid is manufactured in this country, chiefly by the fusion of sawdust with a mixture of caustic soda and caustic potash. The cellulose of the wood undergoes decomposition, and on extracting the mass with water, a solution of sodium and potassium oxalates is obtained. This solution is treated with milk of lime, by which the oxalic acid is precipitated as calcium oxalate, and the caustic alkali remains in solution. The insoluble calcium oxalate is boiled with the requisite amount of dilute sulphuric acid, when calcium sulphate and oxalic acid result, the latter being crystallized by evaporation. The above process has now been largely superseded by the synthetic production of oxalic acid

which consists in passing carbon monoxide gas over fused alkali under special conditions of temperature and pressure. In the first stage of the process, at a low temperature and comparatively high pressure, sodium formate is produced, but on raising the temperature and reducing the pressure in the second stage two molecules of sodium formate unite to form sodium oxalate with liberation of hydrogen.

Britain consumes considerably more oxalic acid and oxalates than are manufactured in the country, as will be seen by the table below:

EXTERNAL TRADE OF THE UNITED KINGDOM IN OXALIC AND TARTARIC ACIDS AND THEIR SALTS (CWTS.).

Product.	*Source or Destination.*	*Imports.*		*Exports.*		*Re-Exports.*	
		1913.	1921.	1913.	1921.	1913.	1921.
Oxalic acid and oxalates	Empire	No statistics	Nil	No statistics	330	No statistics	625
	Foreign countries		9,620		148		224
	Total ..	—	9,620	—	478	—	849
Tartaric acid and tartrates	Empire	Nil	Nil	6,414	7,582	1,456	245
	Foreign countries	45,936	21,983	9,987	1,181	4,711	393
	Total ..	45,936	21,983	16,401	8,763	6,167	638

Oxalic acid is used for the manufacture of certain organic dyes and in the dyeing industry, and largely for bleaching straw-plait and leather. It finds wide application owing to its power of removing ink-stains, iron-mould, etc. It is also used in the manufacture of inks and as a constituent of metal polishes. In the brewing industry it is sometimes used for cleansing purposes.

Ammonium oxalate is used in important quantities for the manufacture of "permitted" explosives which are employed in mines where fire-damp exists. Acid potassium oxalate, better known as salts of lemon, is used as a mordant in cloth-printing and is employed for the removal of stains.

Tartaric acid and cream of tartar are made in quantity in the United Kingdom with a considerable margin for export. Tartaric acid is extensively employed as a mordant in dyeing and calico-printing, more particularly in the form of tartar emetic, which is a double tartrate of antimony and potassium. Another of its uses lies in ink manufacture. The domestic use of tartaric acid and cream of tartar as a constituent of baking powder is so well known as to need no comment here. Tartaric acid is employed also for the production of mineral waters and effervescing medicines.

We have given statistics showing the import and export trade of the four acids in the present group and their salts. While Norway figures to a great extent as our supplier of oxalic acid, we import the bulk of our supplies of the whole group from the other European countries, and more particularly from Germany and the Netherlands. As a supplier Italy participates in our large purchases of cream of tartar. As regards our export business, citric and tartaric acids only are of any importance, Australia being our best customer.

§ 7

In this group we have placed the remaining organic compounds of which trade statistics are available. The group consists of three articles—namely, acetone, camphor, and glycerine. All these products are of great importance industrially, but glycerine may, perhaps, be considered the most important. We shall, therefore, deal with glycerine first.

It is common knowledge that glycerine is a product of soap and candle works, but it is not so well-known that it is an alcohol. Most fats are a compound of fatty acids with alcohols, such as glycerol or glycerine, and are esters. When these compounds are hydrolyzed by treatment with a caustic alkali, either with or without the application of heat, the fat is decomposed into the fatty acid, which combines with the metallic radicle of the alkali, and an alcohol, generally glycerine. The metallic salt of the fatty acid is soap, which separates, while the glycerine remains in the spent lye. The spent lye is next neutralized with acid and concentrated, the metallic salt of the lye being deposited as crystals; after various processes the crude glycerine is distilled and the pure product obtained. As first produced, it is coloured, and is therefore treated with carefully prepared animal charcoal to decolorize it.

With her great soap-making industries, Britain naturally exports a very large amount of glycerine, but she also imports considerable quantities, of which the greater portion is of foreign rather than Imperial origin.

External Trade of the United Kingdom in Glycerine (Cwts.).

Product.	*Origin or Destination.*	*Imports.*		*Exports.*		*Re-Exports.*	
		1913.	1921.	1913.	1921.	1913.	1921.
Crude glycerine	Empire	16,468	536	1,096	33,397	122	Nil
	Foreign countries	71,440	32,008	144,659	11,860	16,940	Nil
	Total ..	87,908	32,544	145,755	45,257	17,062	Nil
Distilled glycerine	Empire	100	—	76,009	30,143	Nil	12
	Foreign countries	21,976	3,808	20,297	7,346	600	20
	Total ..	22,076	3,808	96,306	37,489	600	32

France is the greatest exporter of crude glycerine to this country. Of 71,440 hundredweights imported during 1913 from foreign countries, France was responsible for 25,536 hundredweights, and Belgium for 13,167 hundredweights. In the same year we imported from British Possessions 16,468 hundredweights, the imports being distributed as follows: Natal 6,194 hundredweights, Australia 7,478 hundredweights, and other Possessions 2,801 hundredweights. In 1921 our total imports from our Possessions were only 536 hundredweights, our chief suppliers in 1913 exporting none to this country. Nor, in fact, did we receive any crude glycerine from either Natal or Australia or Canada in the years 1920 to 1922.

The Netherlands are our biggest suppliers of distilled glycerine, the imports from this source during 1913 being 10,411 hundredweights, and in 1921, 3,762 hundredweights. Our re-exports of glycerine have been inconsiderable since 1913, in which year we exported 17,062 hundredweights of the foreign produced crude product, 11,786 hundredweights going to the United States of America. In 1920, when the boom was at its height, we re-exported 11,804 hundredweights of crude and 37,105 hundredweights of distilled glycerine.

Turning now to exports of crude glycerine, in 1913, while 144,659 hundredweights were exported from the United Kingdom to foreign countries, only 1,096 hundredweights went to British Possessions. Our best customers for the crude product in 1913 and 1921 were the United States and the Netherlands, the former importing 98,546 hundredweights in 1913, and 10,317 hundredweights in 1921. In 1920 and 1921 our exports of crude glycerine to the Dominions rose from 1,096 hundredweights (the amount purchased by them in 1913) to 50,943 and 33,397 hundredweights, and of this South Africa purchased the greater bulk.

Of foreign countries Japan is our greatest buyer of refined glycerine, while Norway is also a good customer on a lesser scale. Our total exports of the refined product to foreign countries in 1913 were 20,297 hundredweights, and in 1921 7,346 hundredweights. In 1922, however, this had increased to 38,402 hundredweights. Of British Possessions, South Africa is the biggest and most consistent buyer, and in view of the volume of our trade in refined glycerine in the Empire, we give below the main features of our exports in full:

EXPORTS OF REFINED GLYCERINE FROM THE UNITED KINGDOM (CWTS.).

Destination.	1913.	1919.	1920.	1921.	1922.
Cape of Good Hope	993	1,014	3,677	164	683
Natal	37,167	5,638	19,002	9,605	793
Transvaal	16,682	2,732	10,437	15,071	10,266
British India	2,685	3,051	2,717	1,204	2,575
Canada	17,414	1	53	1	5,007

The industry causing the greatest demand for glycerine is that of explosives manufacture. Nitroglycerine is not only the basis of the propellant explosive, cordite, upon which we depend so much in time of war, but also of the blasting explosives for which there is a constant demand in time of peace. A mixture of nitroglycerine and kieselguhr is the well-known dynamite of commerce. All gelatine explosives, such as blasting gelatine, gelatine dynamite, and gelignite, have nitroglycerine as their basis also. Glycerine has other important uses, such as in the confectionery trade, and in the manufacture of copying inks, shoe polish, etc. It is also employed as a non-congealing liquid in gas meters, in calico-printing and for keeping leather goods and textiles to be dressed soft and pliable. In addition to the above it is used in certain soaps and also medicinally.

Acetone occurs in wood distillates, but is manufactured by the dry distillation of acetate of lime, and by fermentation processes in which starch from maize or other grain is converted into acetone and butyl alcohol. When it became

necessary to produce large quantities of acetone for war purposes the latter process was employed in this country, in Canada to a greater extent, and in America.

Of our imports from foreign countries in 1913, 15,924 hundredweights were from the United States, 13,600 hundredweights from Austria-Hungary, and 8,619 hundredweights from Germany. In 1921 our total imports were less than our purchases from Germany alone in 1913, and Germany herself was our chief supplier. Our imports from Empire sources are not very great, and their origin is not stated, although it is presumed that Canada would be the greatest manufacturer. Our export trade is not of great consequence, as will be seen from the following table:

External Trade of the United Kingdom in Acetone and Camphor (Cwts.).

Product.	*Source or Destination.*	*Imports.* 1913.	1921.	*Exports.* 1913.	1921.	*Re-Exports.* 1913.	1921.
Acetone	Empire	7,830	1,723	No	128	Nil	46
	Foreign countries	38,577	3,585	statistics	3,003	1,094	137
	Total ..	46,407	5,308	—	3,131	1,094	183
Camphor	Empire	No	1,414	No	114	No	320
	Foreign countries	statistics	7,111	statistics	483	statistics	6,080
	Total ..	—	8,525	—	597	—	6,400

No statistics are available for exports during 1913, but since 1921 our exports of acetone have not been worthy of comment.

Great quantities of acetone are consumed in the manufacture of artificial silk and cordite. It has the property of dissolving guncotton, the resulting mass after the addition of nitro-glycerine being known as cordite " paste." The paste is passed through incorporaters and then pressed, after which a considerable percentage of the acetone is recovered by heating the cordite, laid on open trays in " stoves."

Large quantities of acetone are employed for making solutions of acetylene gas for welding. The solution is packed in steel cylinders, and the acetylene is thus obtained in a readily movable package.

Acetone is also largely used in the manufacture of chloroform, and is a valuable solvent of organic compounds. It is also employed in making certain dopes and varnishes and cinematograph films.

Natural Camphor is a product of the camphor tree, from which it is obtained by steam distillation. The camphor tree is indigenous to China, Japan, and Southern Asia, and it therefore follows that Britain is an importer. Camphor, however, is now also prepared synthetically.

Import figures for 1913 are not available, but in 1921, 3,122 hundredweights of Chinese and 3,277 hundredweights of Japanese origin were imported into Britain Hong Kong also supplying, presumably from the same source, 1,392 hundredweights.

Our export trade in camphor is negligible, the largest individual buyer being France, which purchased 171 hundredweights. A very considerable re-export trade, however, is carried on, and, to give a few instances, in 1921, Britain re-exported 1,196 hundredweights to Germany, 2,243 hundredweights to the Netherlands, and 1,783 hundredweights to France, all of it being of foreign manufacture.

Camphor is chiefly used for the manufacture of celluloid, although it also finds extensive application as an insecticide and moth preventive. It is also employed in the making of fireworks, and to some extent medicinally.

§ 8.

For many years Britain relied to a great extent on the kelp industry for her supplies of raw potash. Potassium salts occur in vegetable matter, and most wood ashes contain them in appreciable amounts, while this is particularly noticeable in the ash of certain seaweeds. During certain periods of the year enormous quantities of seaweed, known as kelp, are washed ashore on the coasts of Scotland, and this has been, in the past, the source of quite a thriving industry in that country.

After the discovery of the vast deposits of potash salts at Stassfurt, which are now world famous, the enormously increased production very naturally resulted in a great decrease in price of potassium compounds, the competition finally rendering the kelp industry unremunerative. Even at the present time, however, a small amount of potash is still produced in Scotland from kelp. The only other source of potash of any consequence in the United Kingdom is blast furnace dust, which is to-day used as a fertilizer in its virgin state, though potash occurs also in cement kiln dust and wood grease residues. The great bulk of our supplies of potash is now imported from the Stassfurt deposits and those of Alsace-Lorraine, and potash salts enter Britain chiefly in the form of chloride, sulphate, and nitrate.

British Customs statistics showing the imports and exports of potassium salts, with the one exception of potassium nitrate, are not available for the year 1913, and our table, therefore, shows only 1921 statistics. It is possible, however, to obtain from official German returns the amounts of potash salts exported from Germany to the United Kingdom in 1913, which were as follows:

Potassium sulphate	277,740 cwts.	Potassium chromate and bi-chromate	5,780 cwts.
Potassium carbonate	50,274 „	Potassium ferro- and ferri-cyanides	8,322 „
Potassium chloride	381,834 „		

We have mentioned in another section that potash deposits exist in India, and in 1913 the United Kingdom imported 60,006 hundredweights of potassium nitrate from that country, this amount being increased to 82,727 hundredweights in 1921. During 1913 our total imports of nitrate of potash amounted to 237,880 hundredweights, of which Germany supplied 149,975 hundredweights and Belgium 25,469 hundredweights, representing, no doubt, the amounts from Stassfurt and Alsace-Lorraine respectively.

External Trade of the United Kingdom in Potassium Salts in 1921 (Cwts.).

Product.	*Source or Destination.*	*Imports.*	*Exports.*	*Re-Exports.*
Potassium sulphate	Empire	2,640	486	956
	Foreign countries	53,301	5,062	12,541
	Total	55,941	5,548	13,497
Potassium nitrate	Empire	82,727	4,842	2,563
	Foreign countries	32,675	5,701	4,973
	Total	115,402	10,543	7,536
Potassium carbonate	Empire	72	324	216
	Foreign countries	31,610	320	2,682
	Total	31,682	644	2,898
Potassium chlorate	Empire	40	3,682	86
	Foreign countries	23,121	1,702	48
	Total	23,161	5,384	134
Potassium chromate and bichromate	Empire	Nil	4,795	Nil
	Foreign countries	560	4,938	7
	Total	560	9,733	7
Potassium permanganate	Empire	Nil	281	93
	Foreign countries	3,775	40	63
	Total	3,775	321	156
Potassium ferro- and ferri-cyanides	Empire	Nil	136	37
	Foreign countries	4,265	279	17
	Total	4,265	415	54
Caustic potash and lyes	Empire	64	615	98
	Foreign countries	43,010	87	799
	Total	43,074	702	897

In spite of the fact that the United Kingdom imports practically all its potassium in some form or another, potash salts are, nevertheless, of importance from the point of view of the British manufacturer. It will be seen from the foregoing table that considerable quantities of the nitrate, chlorate, chromate, and bichromate were exported from this country, and, in fact, these salts, together with the permanganate, constitute the chief manufactures of potassium salts in this country. The re-exports in all cases are not sufficiently

large to be worthy of note, although that of sulphate of potash amounted to 13,497 hundredweights in 1921.

Potassium iodide statistics are not given in this section, as we have classified this material as a fine chemical, and it will be dealt with in a later section. The chloride also is more properly a fertilizer, except in so far as it is the raw material for a great deal of our potassium salts manufacture.

Turning now to potassium nitrate, this material is made in Britain in important quantities. Of the Dominions, Australia and South Africa are our best customers. In 1913 Australia bought 5,833 hundredweights and South Africa 1,407 hundredweights, while in 1921 these figures had fallen to 2,712 and 1,022 hundredweights respectively. Potassium nitrate can be manufactured by a process of evaporating solutions of potassium chloride and sodium nitrate together in the correct proportions. The potassium salt, being much less readily soluble, crystallizes first, and is sometimes known as " convert nitrate."

Potassium nitrate, or saltpetre, is used in the manufacture of black gunpowder, which is a mixture of sulphur, nitrate of potash, and charcoal. Gunpowder owes its power as an explosive to the great volume of gases which is produced during its combustion, the nitrate of potash being capable of supplying all the oxygen necessary to burn the other ingredients. Nitrate of potash is also used in the match industry, for the same reason as in the case of gunpowder. As a fertilizer it finds considerable application, since its nitrogen appears to be in an easily assimilable form.

Potassium carbonate is another very important compound on account of its value in the manufacture of soft soap, but it will be seen from the table of statistics that the United Kingdom is essentially a purchaser of potassium carbonate, since our exports in the years 1920 to 1922 only amounted to 8,483, 644, and 4,596 hundredweights respectively. The imports for the same period, on the other hand, amounted to 23,119, 31,682, and 70,221 hundredweights.

Potassium carbonate, besides being extensively used in the soap industry, finds application also in the manufacture of mineral water and in the glass and pottery trades.

Potassium chlorate, again, is a compound of which the United Kingdom is an importer. It is produced on the Continent in great quantities by an electrolytic process, and is a very powerful oxidizing agent, on which account it is used in the manufacture of coal tar colours. It is also largely employed in calico-printing and the match industry.

Bichromate of potash is also one of the most important of the compounds of potassium. It is used in bleaching oils and fats, and also in making varnishes. In the photographic material industry it is mixed with gelatine to render that substance insoluble. Perhaps the greater demand for it arises from its use as a mordant in dyeing with alizarine colours, and it is also employed in calico-printing and for making inorganic pigments. From the statistical table it will be seen that bichromate is exported from this country in quite appreciable quantity. In 1913, 55,846 hundredweights were exported, and of this 23,152 hundredweights were shipped to Germany and 10,575 hundredweights to France. Of our trade with the Dominions in this compound, Egypt was formerly our best customer

and British India second; 2,544 hundredweights were exported to India in 1913 and 787 hundredweights in 1921, the figures for Australia during those years being 1,810 and 907 hundredweights. By 1922 our total exports of potassium bichromate had risen again to over 23,000 hundredweights.

Of the compounds of which statistics have been given, caustic potash, permanganate, and ferro- and ferri-cyanides remain. Our imports of all these compounds exceed our exports to a very considerable extent, and, as this volume is designed primarily to foster export trade in so far as the United Kingdom is concerned, we do not propose to deal with them very fully. It may, however, be of interest to give a short account of their chief uses.

Caustic potash, as would be expected, is consumed by the soap maker in the manufacture of soft soaps, which is its chief market. It is also employed in process engraving and, to some extent, in making dyes. Permanganate of potash is used in the leather trade and is consumed in considerable quantities as a disinfectant both for rough use and in medical cases. Potassium ferrocyanide is employed for the manufacture of prussian blue and also in the case-hardening of steel. It is also used in photography and calico-printing. The ferri-cyanide is chiefly used in the production of engineer's photo-printing paper.

The export trade in potash salts is carried out chiefly by merchants. From the figures which have been given it is obvious that none of the potassium compounds is handled in very large quantities, and the merchant houses serve a useful purpose in distribution of this nature. Only in the form of manures, such as kainit, are the quantities shipped very great, and the sales of bulk quantities are chiefly made by the original suppliers abroad. To sum up, Britain must rather look to increase her trade in those products which require potash salts for their manufacture than in the actual potash salts themselves.

§ 9.

In this, the last group of the heavy chemicals, we shall deal with ammonia and a few of its salts, excluding sulphate of ammonia, which is treated in the fertilizer section, and with carbonic acid gas. First, there is anhydrous ammonia, considerable quantities of which are exported from this country annually; then we have also the chloride and carbonate. Ammonium nitrate is used in the manufacture of modern high explosives and in compound fertilizers, but we are dealing with it here rather than in the fertilizer group, as its use in Great Britain as a fertilizer is at present negligible.

Anhydrous ammonia is imported into Britain in competition with the home produced article, in spite of the fact that we should be able fully to satisfy our own needs and those of the entire Empire from our own resources. For instance, in 1920, 1,472 hundredweights were imported into the United Kingdom, in 1921 2,848 hundredweights, and in 1922, 2,961 hundredweights. The largest proportion of these imports was of American origin, none whatever coming from Empire sources.

Exports of British anhydrous ammonia amounted to 3,133 hundredweights in

1921. The destinations of our foreign exports are not given in the trade returns, but our best customers within the Empire are South Africa and India.

External Trade of the United Kingdom in Anhydrous Ammonia (Cwts.).

Source or Destination.	*Imports.* 1913.	*Imports.* 1921.	*Exports.* 1913.	*Exports.* 1921.	*Re-Exports.* 1913.	*Re-Exports.* 1921.
Empire	No statistics	Nil	No statistics	2,335	No statistics	54
Foreign countries.. ..		2,848		798		7
Total	—	2,848	—	3,133	—	61

Anhydrous ammonia is largely produced and employed for refrigerating purposes. Aqueous ammonia, for which no figures are available, is used in a multitude of ways. First, it is employed in the manufacture of ammonium salts and for the production of ammonia for the ammonia-soda process of producing alkalies, to which we have already referred in the opening section of this chapter. In the gas works, where it is produced, it is used for the manufacture of ammonium sulphate and muriate, and nitrate can also be made therefrom. It is also used in dyeing and in miscellaneous industries.

We give below the official statistics for the ammonia group:

External Trade of the United Kingdom in Certain Ammonium Products (Tons).

Product.	*Source or Destination.*	*Imports.* 1913.	*Imports.* 1921.	*Exports.* 1913.	*Exports.* 1921.	*Re-Exports.* 1913.	*Re-Exports.* 1921.
Ammonium chloride	Empire	Nil	Nil	799	1,125	4	1
	Foreign countries	374	329	3,974	1,476	1	4
	Total ..	374	329	4,773	2,601	5	5
Ammonium carbonate	Empire	No statistics	Nil	310	240	No statistics	Nil
	Foreign countries		7	3,575	933		Nil
	Total ..	—	7	3,885	1,173	—	Nil
Ammonium nitrate	Empire	No statistics	Nil	No statistics	248	No statistics	130
	Foreign countries		1,948		1,457		Nil
	Total ..	—	1,948	—	1,705	—	130

It will be seen that our export trade in these ammonia compounds is considerable. Turning again to sal ammoniac, comparatively little is imported into this country; the bulk of such imports as are made is of German origin, the quantity from this source for 1913 being 297 tons, and for 1921, 246 tons. Re-exports in the whole of the ammonium compound group are negligible.

Concerning the exports of British sal ammoniac, in 1913 our best market was the United States, to which we sent 1,919 tons. The rest of our exports to

foreign countries were about evenly distributed to European countries. In 1921 the total exports to foreign countries had fallen to 1,476 tons, but this can scarcely be taken as an average year, since in 1920 we exported 5,340 tons and in 1922, 4,484 tons. In these two years Japan, the United States, and France were our greatest buyers.

Our exports to the Dominions maintain a steady average of from 1,000 to 1,500 tons yearly, although sometimes slightly more or less. India is the best Imperial market, having imported from Britain 439 tons in 1913, and 355 tons in 1921, out of totals of 799 and 1,125 tons respectively. Australia and Canada are also important customers.

Ammonium chloride has come into use on the Continent as a fertilizer, but in the United Kingdom the salt is consumed chiefly in electric batteries. It is employed also in pharmacy, soldering, galvanizing, dyeing, and calico-printing.

As regards the carbonate, before the War, Russia was the greatest importer of British carbonate of ammonia, the quantity purchased by her in 1913 amounting to 892 tons. Needless to say, in the past few years the Russian market has entirely disappeared. Of other foreign countries, France, Japan, and the United States are the most important consumers.

British India imports more carbonate of ammonia than any other of the British Possessions. In 1913 she purchased from this country 98 tons, and in 1921 82 tons, this having increased in 1922 to 124 tons. Australia and Canada also import British carbonate of ammonia, but, generally speaking, our export trade in this chemical is to foreign countries.

There have been no re-exports recorded in any year, and the imports in 1921 amounted only to 7 tons. No statistics are given for years prior to 1920.

Ammonium carbonate is used in the manufacture of baking powder, in wool-scouring, and in dyeing processes.

Ammonium nitrate is manufactured by a process of crystallization from ammonium sulphate and sodium nitrate. It is also manufactured synthetically from atmospheric nitrogen in Norway and in Germany, notably at the synthetic ammonia works at Oppau. As would be expected, therefore, our imports are confined to the produce of these two countries. No import statistics are available for the year 1913, but in 1920 Britain imported 3,538 tons from Norway and 232 tons from Germany. In 1921 she imported 1,371 tons from Norway, and 577 tons from Germany; in 1922 she imported only 54 tons from Norway, while the imports from Germany had increased to 2,855 tons.

It will be seen that our total exports of ammonium nitrate in 1921 amounted to 1,705 tons, as compared with 7,501 tons in 1920, and 1,994 tons in 1922. The large amount exported in 1920 was possibly due to the sale of surplus stocks from the War; such stocks of nitrate did, in fact, exist. France was the most important market, having purchased 2,688 tons in 1920, 1,031 tons in 1921, and 1,511 tons in 1922. South Africa imported 204 tons out of a total of 248 tons in the year 1921.

Re-exports of ammonium nitrate are too small to be worthy of mention.

Ammonium nitrate is used chiefly in the manufacture of high explosives, in mixtures with trinitrotoluol, etc., as in ammonal, and also as the main in-

gredient of safety or " permitted " explosives. Not long ago tests were carried out in England to determine the value of ammonium nitrate as a fertilizer, and reports were satisfactory. It has, however, found no extensive use as yet in this direction in the United Kingdom, although double salts of ammonium nitrate and, for example, potash salts have been extensively employed in Germany, and it will be recollected that there was a stock of some 4,500 tons of ammonium nitrate and ammonium sulphate at the Oppau factory at the time of the explosion.

When ammonium nitrate is heated, laughing gas or nitrous oxide and water are formed, and this property is utilized in the manufacture of laughing gas for medicinal purposes.

Carbon Dioxide Gas is the last compound in this group. Our imports were from foreign countries only during the years 1920 to 1922, and amounted to 34,224, 52,193, and 14,808 pounds respectively. Statistics for years prior to 1920 are not available either for imports or exports, but the table following shows imports and exports for the year 1921 :

External Trade of the United Kingdom in Carbon Dioxide Gas in 1921 (Lbs.).

Source or Destination.	*Imports.*	*Exports.*
Empire	Nil	51,152
Foreign countries	52,193	16,736
Total	52,193	67,888

Britain made no re-exports of carbonic acid gas during the period mentioned above, but her exports of home produced material amounted to 150,314 pounds in 1920, 67,888 pounds in 1921, and 95,222 pounds in 1922. Of these exports 125,351 pounds were shipped to British Possessions in 1920, 51,152 pounds in 1921, and 65,155 pounds in 1922.

Carbonic acid gas is produced in vast quantities in almost every industry, and occurs naturally in many mineral springs, in the atmosphere, and in the soil. It is produced in all combustion and by the decay of all organic matter. It occurs in combination with lime in vast quantities, as chalk, limestone, and marble, and as the carbonate of many other metals.

Industrially it is used in great quantities in the manufacture of aerated waters. It is also extensively used in the purification by carbonation of beet sugar.

CHAPTER IV

THE UNITED KINGDOM: COAL TAR AND ITS BY-PRODUCTS

§ 1.

For a great many years tar distillation has been carried on in Britain, but in the early years only antiquated plant was employed and the chief supplies of crude tar were derived from gas works. In recent years, however, the industry has undergone a complete change.

Not so long ago the coke for our blast furnaces was produced in various kinds of coke ovens, of which the " beehive " type was in most general use. This type of oven was open at the top and, as the name implies, shaped like a beehive. The oven was filled with coal which was ignited at the bottom, and the tar produced was burnt or distilled off into the atmosphere, but in no case was any attempt made to collect the escaping gases.

In course of time modern coke ovens of various types were installed to meet the demand of all the great steel works for metallurgical coke, and in 1922 only 30 per cent. of the total number of coke ovens were of the old beehive type. The advent of these ovens resulted in a large production of crude coke oven tar, and, as would be expected, their installation was followed by that of the latest tar distillation plants. To-day the great steel works are amongst the largest producers of coal tar by-products. The total United Kingdom production of coal tar from all sources was about 1,053,000 tons in 1921.

The old types of tar still have been replaced in most cases by continuous distillation plants. Crude tar is pumped from the storage wells into a preheater, where some of the ammonia liquor entangled in the tar is driven off, and then passes into the tar still proper and is heated. Distillation is conducted so as to collect the following main fractions in separate recovery tanks: light oil, carbolic oil, creosote oil, anthracene oil, and pitch. Pitch remains as the residue in the still, and after cooling for some hours it is run from the still to the " pitch bays." The fractions are worked up for benzol and toluol, phenol, cresylic acids, naphthalene, creosote, and anthracene of the particular grades demanded by the various consuming industries.

As the reader will no doubt surmise, the seat of the by-products industry is to be found in those districts which provide sources of tar—namely, the coal-bearing areas in which are situated also the blast furnaces which light up so many miles of our countryside. To name the districts individually would be merely to name the colliery areas, but particular mention must be made of Scotland, Durham, Yorkshire, and Lancashire, the Midlands and South Wales.

It must also be borne in mind that tar distillation plants are to be found in many of the great cities where the consumption of coal gas is very great. The largest and most modern of our gas works to-day distil their tar, and in London alone hundreds of thousands of pounds worth of coal tar products, sulphate of ammonia, etc., are manufactured annually.

During the recent years of depression in trade tar distillers have been comparatively fortunate in that the demand for one class or another of tar products has never actually ceased. At the worst period in the slump supplies of crude tar were curtailed by the drawing of fires in the blast furnaces, and the production of tar distillates practically at no time exceeded the demand. With the re-lighting of the furnaces trade had obviously taken a turn for the better, and the demand for by-products also improved. Again, with continued unemployment, schemes for the reconstruction of old roads and the construction of new roads have been undertaken on a hitherto unprecedented scale, and this has resulted in a demand for many millions of gallons of refined tar for surface spraying. Modern roads are constructed to a large extent with tarred stone or

slag, and the increased demand for this material has naturally created an almost insatiable market for yet further quantities of refined tar. A considerable amount has also been exported to South Africa and other Dominions.

As far as British producers are concerned, the greatest demand for coal tar products of all kinds comes from the United States of America, and the industry in Britain certainly suffered a set-back on the introduction of the Fordney Tariff Act. Fortunately, here again, tar distillers have in a large measure been able to produce products of such specifications as to obtain free entry into the United States, although such materials as flake and crystal naphthalene, refined or even 40 per cent. anthracene, and low boiling cresylic acid, are practically excluded unless buyers are prepared to pay a duty exceeding the actual value of the goods. Such products as the United States is able to produce in sufficient quantity to satisfy her own requirements and at a price with which imports cannot compete—creosote for instance—are on the free list. Without wishing to broach a controversial subject, one can only conclude that the Tariff Act must have given a tremendous fillip to the refining of crude tar products in America.

The difficult situation which arose from the passage of the Fordney Tariff Act was mitigated to some extent by conditions in Germany, although this may sound paradoxical. The Ruhr Basin is the heart of the chemical industry in Germany, and produced sufficient coal tar products to satisfy the requirements of the vast dye works situated on the banks of the Rhine. After the military occupation of the Ruhr Basin by the French the dye manufacturers were cut off from their supplies of raw material. British producers were therefore able to export by-products of all kinds to Germany.

§ 2.

Coal tar products may be classified for purposes of convenience under the following headings: benzols, tar acids, creosote and heavy distillates, naphthalene and pitch.

In the course of tar distillation the first fraction to be obtained is light oil, which contains the low-boiling constituents of the tar. If the distillation be carried no further than this stage the still residue consists of refined tar, which material will be dealt with in the last section together with pitch and bitumen. The latter material, although in no sense of the term a coal tar product, has been included in this group on account of its close alliance with pitch, both in its characteristics and its uses.

Light oil, then, is the fraction from which are obtained crude benzol and crude naphtha, together with a quantity of tar acids. These crude products are washed successively to remove impurities and to extract the tar acids, and are then subjected to further distillation, and ultimately, if desired, it is possible to obtain pure benzol, pure toluol, pure xylol, and heavy naphtha. The "forerunnings" of the benzol distillation contain a high percentage of carbon bisulphide, which is sometimes recovered, but more often, it is to be feared, run into the motor benzol! The production of pure benzol, etc., is comparatively small, however, and the bulk of the crude benzol is merely converted either to "90 per cent." or to

"motor" benzol. The production of benzol reached a maximum figure of 42,000,000 gallons a year in the War, but dropped to about 23,000,000 gallons in 1919-20.

After the benzol fraction has been distilled off the residue in the still consists of naphthas. These residues are allowed to accumulate until sufficient remains to enable them to be washed and redistilled for the production of solvent naphtha and heavy naphtha. These products are produced in considerable quantities, but are mostly consumed in the home markets.

Tar distilleries are not the only source of supply of crude benzol and light oils. Many of the smaller gas works throughout the country have tar dehydrating plants, in which the crude tar is stripped of its light oils in the production of dehydrated tar, which is usually sold to local councils and road contractors, the light oils themselves being bought by tar distillers for refining. Further, a great number of steel works, which have batteries of coke ovens but do not distil their tar, strip their gas of its benzol by scrubbing with absorbing oil of various types. The crude benzol is then removed by distillation from the absorbing oil, which is again employed for further gas scrubbing. Some millions of gallons of crude benzol are probably produced in this manner.

Below are given statistics showing the quantities of the benzol group imported into and exported from the United Kingdom during the years 1913 and 1921. It will be seen that in 1913 the export figures for benzol and toluol were combined, and no import figures were available:

External Trade of the United Kingdom in Certain Coal-Tar Products (Gallons).

	1913.		1921.	
Product.	*Exports.*	*Imports.*	*Exports.*	*Imports.*
Benzol and toluol	6,654,589		—	—
Benzol	—	No	15,632	6,462,536
Toluol	—	statistics	27,919	16,560
Naphtha	515,392		42,925	57,690

Experience in the motor industry has proved that a mixture of benzol and petrol gives more satisfactory results as a fuel than petrol alone, and this fact has naturally increased the demand for benzol to an almost unlimited extent. Not only is the benzol produced here easily consumed, but in the last few years Britain has imported, mainly from the United States of America, several millions of gallons of benzol annually. In fact, the demand for benzol is now almost entirely confined to the field of fuel; it is, of course, used, although in much smaller quantities, as a solvent. Pure benzol is used mainly in the manufacture of intermediate products, as it is the raw material from which nitrobenzene and hence aniline is produced. It is, therefore, the basis of the aniline dyestuff industry. Pure benzol is extensively used in other countries for the production of synthetic phenol, and to a less extent in the United Kingdom, though large quantities of synthetic phenol were produced here during the War.

Pure toluol, the next homologue in the benzene series, is also used in the manufacture of intermediates, but the greatest demand for it arises in the explo-

sives industry for the production of T.N.T. and dinitrotoluol. Pure toluol is the material from which saccharin is synthesized. In the form of " 90's " or " 90 per cent." toluol it is used by some rubber manufacturers in preference to solvent naphtha.

We now come to coal tar naphthas. Light solvent naphtha is used almost exclusively in the rubber industry as a solvent. It is usually sold under the designation of " 90/160," which means that a minimum of 90 per cent. must distil over at 160° C. Most rubber manufacturers stipulate that it shall be " sweet smelling," as the presence of traces of pyridine is considered objectionable. If the naphtha is well washed before the final rectification it should certainly not contain pyridine. It is also employed by dry cleaners, but the demand from this quarter is not large.

Pure xylol, the chief constituent of solvent naphtha, is required for the production of certain intermediates, but it is only a small market, and the standard of purity required is usually that it shall be " water white " and distil within a range of 3° C.

Heavy naphtha, as stated in Chapter IV., is used chiefly in the manufacture of paints. The usual commercial quality distils 90 per cent. at 190° C., but is not necessarily required to be water white. Heavy naphtha has a very high flash point, and this fact renders it particularly suitable for use in the manufacture of paint, where the mixing is often carried out in open heated pans with the consequent risk of fire.

§ 3.

We now come to the consideration of tar acids. In this important group are included all the acid substances which occur in tar distillates, and of which carbolic acid crystals or phenol and cresylic acid are the most important. It will be seen from the Customs statistics which are given below that only carbolic acid is mentioned, but the figures presumably include those for cresylic acid or " liquid carbolic."

External Trade of the United Kingdom in Carbolic Acid (Cwts.).

Source or Destination.	*Imports.*		*Exports.*		*Re-Exports.*	
	1913.	1921.	1913.	1921.	1913.	1921.
Empire	No	Nil	7,666	5,504	Nil	Nil
Foreign countries ..	statistics	6	161,218	50,823	Nil	Nil
Total	—	6	168,884	56,327	Nil	Nil

Tar acids are removed from the various distillates by washing with caustic alkali solution, and two definite types of crude products are obtained. The process depends upon the difference in acidity of phenol and cresol, one dissolving in a weak solution of caustic soda whilst the other remains unaffected. By this selective washing crude carbolic acid and crude cresylic acid are obtained. The former is usually made in two strengths—namely, either 50's or 60's. These terms signify that either 50 per cent. or 60 per cent. of phenol will crystallize

at 62·5° F. The crude carbolic and cresylic acids may be either worked up by the producers or sold to refiners.

We have, then, two crude materials from which the refined products are obtained. Broadly, carbolic acid crystals are the final product obtained from crude carbolic acid, and pure cresols (cresol occurs in three modifications, ortho, meta, and para) may be obtained from crude cresylic acid. The amount of pure cresols manufactured is relatively small, however, and the cresylic acid of commerce consists of a mixture of the three isomers. It is sold in two grades, the pale 97 to 99 per cent. and the dark 95 to 97 per cent.

After the final distillation of cresylic acid a quantity of high boiling tar acids remains. These acids, which are known by the name given above, possess very high germicidal properties, which fact, combined with their relative scarcity, enables them to command a high price.

Phenol obtained from coal tar distillates, as opposed to the synthetic product, is sold mainly as carbolic acid crystals. There is a considerable demand for phenol in the dyestuff industry, and large quantities are used in the manufacture of salicylic acid and salicylates and in the manufacture of phenol-aldehyde synthetic resins. Large quantities are exported and went principally to Germany, the Netherlands, Japan, and the United States in 1922. A further important use to which it is put is the manufacture of picric acid or trinitro-phenol for explosives.

Cresylic acid, the liquid carbolic acid of commerce, is used in a variety of different trades, but perhaps the greatest demand arises in the disinfectant and sheep-dip industry. Cresol, like phenol, is also used in important quantities in the manufacture of artificial amber, a synthetic resin. A considerable amount is required for the production of carbolic soaps and lysols; and in certain instances it is used as an alternative for creosote in the preservation of timber. It is exported in great quantities to the United States of America, which is the biggest market.

High boiling tar acids are used exclusively in the manufacture of high coefficiency disinfectant fluids.

§ 4.

The third group of tar products, which we have already mentioned, is the creosote and heavy distillates group. Creosote is the most important product and is produced in enormous quantities. It is the fraction that distils roughly between the temperature of 200° C., and 300° C., and contains also the naphthalene which may or may not be separated, according to the requirements of the distiller concerned and the market conditions. It contains on an average between 7 to 13 per cent. of tar acids, and is sold in various qualities. If the naphthalene be not removed the creosote is sold as " salty " oil, usually liquid at 90° F.; if the naphthalene is removed the oil is generally sold as liquid at 60° F., or even 50° F.

Specially distilled creosotes, containing high percentages of tar acids, are also manufactured and known as cresylic creosote. Another special creosote was used for the scrubbing of coal gas, to remove the benzol and toluol, a

process mentioned in dealing with the source of supplies of crude benzol earlier in this section. This type of creosote is usually known as benzol-absorbing oil.

The last product in this group is anthracene oil, which contains the anthracene in the form of salts in the same manner as naphthalene occurs as creosote salts. The product is also known commercially as green oil, and is sold as either "strained" or "salty" oil, but unlike creosote it cannot be used in the "salty" condition on account of the insoluble nature of the anthracene even at relatively high temperatures.

The creosote group of distillates is used almost exclusively for the preservation of timber. Ordinary rough salty creosote is exported to the extent of many millions of gallons annually to the United States of America alone, for the creosoting of railway sleepers. It is bought in Britain by the Railway Companies in very large quantities for the same purpose. The export market for creosote is by no means confined to the United States, although they are, of course, the biggest buyers. In the statistics which are given below it will be seen that the whole of the creosote group is dealt with under one heading. We have also given figures which show the amounts exported respectively to foreign and Empire markets. Of the former America was responsible for nearly 34 million gallons in 1913, and nearly 12 million gallons in 1921, and 18 millions in 1922.

External Trade of the United Kingdom in Heavy Coal-Tar Oils (Gallons).

Source or Destination.	*Imports.*		*Exports.*	
	1913.	1921.	1913.	1921.
Empire	No	Nil	637,294	199,053
Foreign countries	statistics	1,738,423	36,120,498	13,799,678
Total	—	1,738,423	36,757,792	13,998,731

The cresylic creosote to which we have already referred is the basis of almost all coal tar disinfectants which consist of emulsified creosote, and it commands a considerably better price than the ordinary rough oil. Apart from the considerable demand arising in the home market for the above product, it is also exported to South America, the United States, India, etc., in considerable quantities for the same purpose.

Anthracene oil is used for the preparation of special wood preservatives and stains, for which it is especially suitable on account of its high specific gravity and consequently high power of penetration.

§ 5.

The fourth and very important group of tar products consists of naphthalene and anthracene. Each is the basis of an important group of dyestuffs—naphthalene of synthetic indigo and anthracene of the alizarine series.

Naphthalene is obtained in its crudest form by cooling the creosote fraction, and there is now such a demand from America for crude naphthalene, owing to

the Tariff Act, that perhaps a few words on the various types of crude products may not be out of place. From the refiner's point of view, it is desirable that the crude should contain the minimum quantity of oil and dirt. When crude naphthalene is destined for the refiner it is usually either "whizzed" or "hot-pressed," the former process removing the oil by centrifugal force and the latter by means of the filter press. Low-grade naphthalenes have a melting-point of anything up to 70° C., and refined naphthalene of 78° C. or even higher. Moderately good crude material may be obtained by allowing the "salts" to drain for a long period.

Refined naphthalene is sold in a variety of forms, of which the most important are the crystals, flakes, and balls. The first named consists of broken lumps of crystal, the second of sublimed naphthalene, and the third of the crystal pressed into ball form. It is also sold in smaller quantities in the form of tablets and candles.

The greatest demand for refined naphthalene arises in the dye industry and for the manufacture of intermediates, the product being sold for this purpose in the crystal form. There is also a very great demand for flakes for use as a preventative of moth and other insect life, naphthalene being in the nature of a dry disinfectant, while the balls are employed for the same purpose.

Prior to the passage of the Tariff Bill the United States bought huge quantities or refined naphthalene, but imports into that country are now subject to a heavy duty. The crude material is, however, permitted free entry under certain conditions, so the demand is merely transferred from the refined to the crude product. Of exported naphthalene by far the greatest quantity goes to America.

Below are given the trade statistics for the United Kingdom, both in naphthalene and anthracene.

External Trade of the United Kingdom in Naphthalene and Anthracene (Cwts.).

Product.	*Source or Destination.*	*Imports.*		*Exports.*	
		1913.	1921.	1913.	1921.
Naphthalene	Empire	No	Nil	11,463	8,777
	Foreign countries ..	statistics	2,416	74,590	26,661
	Total ..	—	2,416	86,053	35,438
Anthracene	Empire	No	Nil	Nil	Nil
	Foreign countries ..	statistics	13,248	5,039	14
	Total ..	—	13,248	5,039	14

As will be seen, the quantities of anthracene exported are trifling as compared with naphthalene, and it is in fact true that Britain is a buyer rather than a seller. Anthracene is obtained from the green oil fraction in the distillation. The crude product is usually worked up by producers until it has a purity of 40 per cent., in which form it is sold to refiners. It is separated from its impurities by extraction with a suitable solvent, and finally it is refined to a purity of about 95 to 98 per cent.

Anthracene is used almost exclusively for the manufacture of anthraquinone.

From the residue left after the production of pure anthracene a mixture of much less known products remains, but one at least—namely, carbazole—is worthy of mention. It is produced only in small quantities and is used in the manufacture of certain vat dyes, and seldom attains a purity exceeding 95 to 97 per cent.

§ 6.

There is now left only what we have termed the pitch group, which consists of refined tar, pitch, and bitumen. Refined tar is a fraction of coal tar prepared in accordance with the Road Board specification, which requires that the product shall be free from water, that it shall yield practically no light oil distillate, and that it shall yield the percentage of distillate specified at various temperatures, etc. Pitch is the residue remaining in the still after the distillation of all volatile oils from the tar; bitumen is not a coal tar product, but is included here for convenience on account of its standing in the same relation to crude petroleum as does pitch to crude tar.

Pitch is employed in the manufacture of briquettes, an artificial fuel, consisting essentially of a mixture of pitch and coal dust pressed into bricks in the presence of some suitable binding material. Compared with its use in this industry, any other uses to which it is put are inconsiderable. It is bought in enormous quantities for this purpose, not only in the home market, but also for export. The bulk of this export goes to France and Belgium, Spain also being an important buyer. Pitch is used also for paving roads with granite "sets" and wooden blocks.

External Trade of the United Kingdom in Coal Tar, etc. (Tons).

Product.	*Source or Destination.*	*Imports.* 1913.	*Imports.* 1921.	*Exports.* 1913.	*Exports.* 1921.	*Re-Exports.* 1913.	*Re-Exports.* 1921.
Coal tar	Empire	No statistics	542	1,307	1,982	No statistics	Nil
	Foreign countries		380	3,091	806		Nil
	Total ..	—	922	4,398	2,788	—	Nil
Coal-tar pitch	Empire	No statistics	Nil	3,531	4,223	No statistics	Nil
	Foreign countries		568	483,037	300,012		1
	Total ..	—	568	486,568	304,235	—	1
Bitumen and asphalt	Empire	33,265	22,021	—	—	4,233	1,246
	Foreign countries	114,806	70,882	—	—	2,694	3,604
	Total ..	148,071	92,903	—	—	6,927	4,850

Refined and dehydrated tar are sold in enormous quantities for the repair and construction of roads, and such work is virtually the only source of demand. It is used to a small extent in the manufacture of roofing felts and like materials. For road work two specifications have been drawn up by the Ministry of Trans-

port, with a view to standardizing supplies. Tar of the No. 1 specification is of thinner consistency and is used for surface spraying, while the No. 2 material is used in the preparation of macadam.

There is an active export trade in tar as in the case of pitch, but quite a considerable portion of the exports are to the Dominions, whence there is a steady demand. On the other hand, demand from foreign countries is sporadic, Russia being our biggest customer in 1913, and France and Spain in 1922. The Customs returns are as given on p. 72.

Bitumen is a material which is becoming increasingly popular in road work of all kinds. It is mixed with refined tar and used both in the manufacture of macadam and in surface spraying. Recently attempts have been made to emulsify it, so that it may be sprayed on the roads without any admixture of tar, and already such emulsions have made their appearance on the market. Large quantities are imported into Britain, and it is produced as a by-product in refining imported crude petroleum.

This concludes the coal tar products section, with the exception of one product, pyridine, for which no statistics are available. This material exists in tar in minute quantities only, the total production in Britain being quite small. It is used to some extent in the dye industry, but its chief application is as a denaturant of industrial alcohol; it is particularly suitable for this purpose on account of its nauseating smell.

§ 7.

Before concluding our outline of the coal tar by-products industry a few words on distribution are necessary. Some of the largest tar distillers have their own sales organization, and have agents abroad, but this is by no means general throughout the industry.

Buyers in foreign countries in isolated cases have their own representatives in England, but this is almost the invariable rule with those in the British Dominions.

CHAPTER V

THE UNITED KINGDOM: INTERMEDIATES AND DYESTUFFS

§ 1.

THE coal tar dyestuff industry in this country has now reached a position of considerable importance economically, apart from its existence being a vital factor in time of war. The large extension of our industry may be considered almost entirely a war-time growth. The discovery of the first coal tar dyes is to England's credit, and they were to a considerable extent manufactured here, but apparently those who controlled the business in this country were not as far-seeing as those in Germany and the industry passed out of our hands. The German mind and character are well fitted for the often very tedious research work involved in the discovery and perfecting of dyestuffs, and the combined abilities of Germany's chemists and business men enabled her to progress from a small range of colours

of, on the whole, no notable fastness, to the large range of every shade and property for which England was before the War one of her best customers, if not quite the best.

§ 2.

Coal is, of course, the fundamental raw material of this industry, and it has been suggested that English coal possesses certain qualities from the colour maker's point of view that cannot be obtained in the coal of other countries. Whether this is correct or not, the fact remains that Germany bought a considerable quantity of coal tar crudes from us before the War, and there is therefore no doubt as to our possession of the first essential for a successful dyestuff industry.

§ 3.

Before the War each of the large German producers had his representative in this country, who carried stocks of the colours and was also in a position to give expert technical advice to customers, and this assistance in the problems that arise from time to time in the dye house was undoubtedly a great help in furthering sales. The power of the German sales organization in this country will be referred to later on.

§ 4.

It is, perhaps, not generally realized to what an extent the trade of this country is dependent upon colours. The greatest volume of trade dependent upon them is probably that of the textile industry, in which for 1913 the dyed textile exports were valued at something like £200,000,000, to say nothing of the many millions of pounds worth of dyed goods used at home, and the textile dyer and printer is, of course, the colour manufacturer's best customer. A considerable demand, however, comes from the paint trade, for striking "colour lakes"—the dry colours used for the finer shades in paints and enamels of good quality. The leather manufacturer requires colours in large quantities for black and brown upper leathers, apart from art shades for cushions, ladies' bags and other fancy leather goods. The paper trade uses a fair quantity of colour for art shade papers, and the wallpaper trade for staining, though mineral colours are used for such material as brown wrapping paper, chiefly for reasons of economy. The straw hat body and plait industry causes a demand chiefly for acid and direct colours, while the varnish and stain manufacturer calls for spirit-soluble and oil-soluble colours. Writing inks are made from the water-soluble colours such as naphthol blue-black, acid scarlet, etc. Another consuming industry is that of fur-dyeing, where such common furs as rabbit ("coney"), etc., are made to look like the most expensive, such as silver fox, sable, etc. The class of colours used for furs was, before the War, largely the special preserve of the Berlin Aniline Company, and in this section there lies, in our opinion, room for improvement in this country, but we will go further into this question when we consider the post-war position of the industry.

A considerable quantity of harmless colours is used in essences, confectionery, and like articles. Only colours made to an exceptional standard of purity are used for any article of food or drink.

The makers of foodstuffs fully realize that any trouble due to harmful impurities in their products would be sufficient to close their businesses. Every colour, therefore, is most thoroughly tested before being used, and when it is realized that, apart from the colour itself being pure, the proportion of colour in the finished food is very small, it will be understood that any prejudice which in the past may have existed against the use of coal tar colours in this connection is without foundation. The chief colours used for foodstuffs are oil yellow and orange for margarine, and water-soluble colours for essences, sweets, custard powder, etc.

Other manufacturers needing colours on a smaller scale are those producing boot polishes and creams, emery paper, buttons, cinematograph films, jute matting, rush matting, soap, perfumery and artists' water colours, to name only a few, and it will be realized, therefore, that good colours may be considered an essential factor in the prosperity of Great Britain.

§ 5.

When the War broke out, less than 20 per cent. of the colours used here were actually made in this country. Several firms were making dyes, but, through force of competition, British makers had as a generalization either been compelled to join the various German conventions and submit to German dictation as regards the scope of their manufactures, their selling prices, and the delimitation of their markets, or were crushed out of existence.

Thus our industry such as existed was far from being self-contained, the Germans carrying out the important processes in their own factories, and was in reality nothing more than a tributary of the German industry. The efficient German sales organization was all a part of this scheme of "peaceful penetration."

We had very little export trade, Germany doing the bulk of the world's business direct, except for a small contribution from Switzerland. The figures given in the Customs returns for 1913 are:

External Trade of the United Kingdom in Coal-Tar Colours, etc., in 1913 (Cwts.).

Imports.		*Exports.*			*Re-Exports.*
Product.	*Quantity.*	*Product.*	*Destination.*	*Quantity.*	*Quantity.*
Alizarine and anthracene dyestuffs	60,813	Coal-tar dyestuffs, including synthetic indigo	Empire ..	13,368	340
Aniline and naphthalene dyestuffs	283,027		Foreign countries	35,305	2,978
Other coal-tar dyestuffs	155		Total ..	48,673	3,318
		Intermediates*	Empire ..	505	—
			Foreign countries	11,555	—
			Total ..	12,060	—
Grand total ..	343,995	—	Grand total	60,733	3,318

Intermediates are included in the exports shown here in order to give a fair comparison, as hey are apparently included in the imports as dyestuffs.

It has not been considered necessary to show the source of the imports, as these were almost entirely of German origin, and it may be taken from the facts given above that these imports show fairly accurately the country's needs in 1913, although some allowance must be made for colours sent into the country for stock purposes.

These figures are, of course, grouped under very broad headings, and it may be interesting, therefore, to note that at the request of the Board of Trade a committee of important men in the consuming industry spent a great deal of time in an endeavour to get out a detailed statement of the 1913 imports of colours, etc. Their efforts were surprisingly successful, as they managed to trace 40,071,368 pounds out of a total of approximately 41,203,000 pounds shown in the official returns, and the full report was published by the Government under the title "Statistics of the Synthetic Dyestuffs imported into the United Kingdom during the Year 1913." Space does not permit us to give the detailed figures here, but we think the following summary abstracted from this report will be of value:

Summary of the Imports of Dyestuffs, etc., into the United Kingdom in 1913 (Lbs.).

Class of Product.	*Quantity.*	*Class of Product.*	*Quantity.*
Direct cotton colours	6,976,435	Vat colours	588,445
Union colours	115,794	Oil, spirit, and wax colours ..	42,253
Acid wool colours	5,223,101	Lake colours	1,082,079
Chrome and mordant colours	6,477,065	Intermediate products	7,467,795
Alizarine	2,467,489	Unclassified	277,872
Basic colours	1,599,074		
Sulphide colours	3,923,483	Total	40,071,368
Synthetic indigo	3,830,483		

It would be interesting to compare with these pre-war figures the extent to which the United Kingdom is to-day dependent upon outside sources for coal tar colours and intermediates, class by class. The import statistics for 1921 and 1922, which will be given in a later section, may be taken as showing the country's total outside supplies of colour in those years, but they do not represent an accurate statement of the needs which cannot be filled by the British maker, as will be shown in due course, while they are also grouped under very comprehensive headings.

We are, therefore, very grateful to the Board of Trade for according us permission to print the following abstract of particulars relating to import licenses granted in the year 1923, information which up to now has not been accessible to the general public.

Summary of Imports of Colours, etc., Licensed in 1923 (Lbs.).

Class of Product.	*Quantity.*	*Class of Product.*	*Quantity.*
Direct cotton colours	614,937	Vat colours	390,956
Acid wool colours	611,709	Oil, spirit, and wax colours ..	7
Chrome and mordant colours ..	781,609	Lake colours	166,603
Basic colours	117,604	Dry and pigment colours ..	6,500
Sulphide colours	214,322	Intermediate products	420,716

In addition to the quantities shown in this table, licenses were granted for relatively insignificant amounts of printing inks and unclassified products.

These figures present the most accurate and detailed picture that it is possible to give of the country's outside needs to-day, but it must be clearly understood that they are decidedly unjust to the British manufacturer, first because they include licenses granted on the score of price, and secondly, because it is well known that many licenses are applied for and granted, but never used.

The fact that the industry is going steadily and consistently forward is shown by the fact that the quantity of colour licensed quarter by quarter shows a general downward tendency over the year, and it may safely be taken that the labours of the Licensing Committee are daily becoming less onerous.

§ 6.

As regards the intermediates from which dyes are made, we were certainly producing aniline oil and salt in 1913, and the export figures are given in our table above (including phenyl glycine, which was probably a small item) as 12,060 hundredweights, which practically all went to Germany. These two articles, however, with some nigrosine and sulphur colours and certain other colours made in the main from imported intermediates, represented, apart from the country's alizarine production, the total of our achievement.

§ 7.

When the War broke out imports from Germany naturally ceased, stocks in the country were low, and in a very short time colours began to get very short and prices rose to unheard-of heights, while the textile and other industries which we have named above were crippled in greater or less degree by the lack of colours.

The country's chemists, as we have indicated in our first chapter, were forced to devote all their time, with few exceptions, to the production of high explosives and the other direct needs of the forces, but in spite of the many difficulties, and particularly of the fact that the newly erected dye works were diverted to the manufacture of service explosives and products for chemical warfare, progress was made, and in addition to supplying suitable dyes for our own naval and military requirements British makers were able to manufacture sufficient dyes to supply part of the military requirements of our allies. When the post-war boom started a number of factories were making colours in important quantities. The Government had previously come to the conclusion that a dyestuff industry was a necessity to the country and had given financial assistance in some cases, the chief instance being its large investment of public money in the amalgamation of previously existing works which is now known as the British Dyestuffs Corporation.

§ 8.

The chief raw materials of the dyestuff industry are coal tar products, such as benzol, toluol, etc., alkalies such as caustic soda, and certain acids; and in the natural course of events the dye-producing factories of this country are mainly

in Lancashire and Yorkshire, where they have, on the one hand, their raw materials within easy reach, and on the other, the chief bulk of their customers—the textile factories—at their very doors, while the ports of Liverpool on the west coast and Hull on the east provide convenient shipping facilities for the export trade.

§ 9.

The first difficulty the new industry had to face was the production of the intermediate products that are the first step towards the finished dyestuffs. The early efforts in this direction were of uncertain quality, and were confined to the simplest articles, such as beta naphthol, nitrobenzol, etc. Steady progress, however, has been made, and the industry is to-day turning out in consistent quality almost every intermediate it needs. Instances of the more generally marketed articles are aniline oil and salt, alpha naphthol, beta naphthol of unvarying quality, alpha and beta naphthylamine, benzidine base, dimethylaniline, H. acid, Gamma acid, a whole range of simple and complex naphthalene sulphonic acids, phenylene diamines, toluidines, chlorbenzenes, paranitraniline, xylidine, while the highly difficult and complex intermediates needed for certain particular colours—*e.g.*, sulpho-phenyl-methyl-pyrazolone for fast light yellow—are well within the present scope of the English dye manufacturer.

High quality intermediates are the first essential for the production of good colours, and it is not surprising that the difficulties under which the British manufacturer had laboured resulted in material being sent out during the boom days which was not of first-class quality. During the slump, however, much research has been carried out and this, coupled with the much improved production of intermediates outlined above, has brought the industry up to a high standard of production.

§ 10.

It has been stated that England now produces almost every colour obtainable in the world, and in at least equal quality with her competitors, and it is certain, at any rate, that every colour of importance can be obtained here in first-class quality and sufficient quantity.

Our pre-war alizarine production has been impoved in quality and range, direct and basic colours of every imaginable shade are offered for cotton and silk, with sulphur and vat colours where especial fastness on cotton is desired. For wool especially are produced acid, chrome mordant, afterchrome, and metachrome colours, while to the British industry alone is attributable the discovery of a totally new class of colours called the ionamines, for the dyeing of acetyl cellulose silk. Oil and spirit soluble colours are available in sufficient variety, and our nigrosines, for leather especially, are possibly a degree better in quality than those of any other country. Special colours, such as pigment scarlet 3 B, etc., are offered for lake makers, while specially pure products are manufactured for foodstuffs, and, as a fairly recent development, for microscopic stains and also for medical purposes. In the case of colours for fur-dyeing a fair range is produced, but we believe that there is room for still further improvement in quality

here, and this view is, perhaps, borne out by the fact that many furs are still sent for dyeing to France and Germany and not entirely for reasons of cost. Research, however, is known to be going on in this direction, and will doubtless bear fruit ere long.

§ 11.

The export trade in colours grew to be fairly considerable in the boom, as the following comparative table will show:

EXPORTS OF COAL-TAR COLOURS, ETC., THE PRODUCE OF THE UNITED KINGDOM (CWTS.).

	Colours.			*Intermediates.*
Destination.	1919.	1920.	1921.	1921.
Empire	44,092*	47,162	35,837	1,062
Foreign countries	64,838*	62,160	12,534	14,081
Total	108,930*	109,322	48,371	15,143

Including synthetic indigo.

We have thought it well to give the several years above as an indication of what the industry has already produced for export, but it is more than probable that these totals could to-day, without difficulty, be greatly exceeded.

§ 12.

The trade in this country is, of course, working under a protective system, whereby the import of colours is allowed only where a satisfactory substitute for the foreign colour required cannot be obtained from the British maker, but this arrangement has been modified to the extent of allowing a certain number of import licenses on questions of price also, and the table below, showing imports in 1921 and 1922, cannot, therefore, be taken as showing the needs of this country that the British maker cannot yet satisfy on the score of quality—it is impossible to distinguish between imports allowed on price grounds and those on the ground that no satisfactory British colour was obtainable.

IMPORTS OF COAL-TAR COLOURS INTO THE UNITED KINGDOM IN 1921 AND 1922 (CWTS.).

Class of Colour.	1921.	1922.
Alizarine colours	11,766	11,387
Other coal-tar colours	40,789	41,090
Total	52,555	52,477

§ 13.

We have, so far, not dealt with synthetic indigo, which, although a coal tar dyestuff, is usually treated as a class by itself. Before the War this product was a German monopoly, the only factory in this country being of German owner-

ship. The imports in 1913 amounted to 23,889 hundredweights, and there were no exports of genuinely British material. As regards the present position, the British Dyestuffs Corporation is the only maker, but its products may be taken as satisfying every need on the score of quality, and a satisfactory export trade is done, as is shown by the following table of exports of home produced indigo paste and powder:

EXPORTS OF SYNTHETIC INDIGO, THE PRODUCE OF THE UNITED KINGDOM (CWTS.).

Destination.	1920.	1921.
Empire	2,960	1,444
Foreign countries	10,858	18,235
Total	13,811	19,679

§ 14.

Without entering upon contentious topics, the need of the industry, at present, seems to be some form of association of interests and pooling of experience amongst the seventeen manufacturers in the country, and we hope to discuss this question at greater length in Part III. of this volume.

It certainly seems to be the case that the industry would be killed almost at once if the present Dyestuffs Import Regulation Act were repealed and free import of colours permitted, and any steps, therefore, towards the increase in range of colours and the reduction of working costs must be regarded as most desirable.

Given a fair field, we have no fear for the future of the dyestuffs industry in this country; we believe it to be so vital to the country that we have devoted, perhaps, more space to our account of it than its yearly output at present warrants. We are certain, however, that British resources and brains are more than adequate to enable us to head the world in the production of intermediates and dyes.

CHAPTER VI

THE UNITED KINGDOM: FERTILIZERS

§ 1.

THE fertilizer industry is of considerable importance in the chemical industry of the United Kingdom. From the time when it was first recognized that chemistry and agriculture bore any relation to one another, Britain has contributed at least a fair share, both to the development of the fertilizer industry and to the actual production of chemical fertilizers. It will, of course, be obvious that the United Kingdom lacks most of the natural resources essential for the production of manures; thus she lacks nitrate of soda, which she imports from Chile, and potash salts, which she imports from Germany and France. Her supplies of

phosphate rock are imported, as are also the pyrites and sulphur from which her sulphuric acid is produced. Where, however, the imported raw material is available, it will be found that this country has a place as both producer and exporter of chemical fertilizers.

The Customs classifications in the fertilizer class were revised between the two years with which we are dealing in this book, and in the result it is difficult to work out reliable pre-war and post-war statistics for comparing, on an exact basis, the situation in these two years of the industry as a whole. As is usual in the United Kingdom, production figures are not available, from the usual official sources, for this industry, but we are indebted to *The International Year Book of Agricultural Statistics*, published by the International Institute of Agriculture, Rome, for production figures for the United Kingdom and the World in regard to certain articles, and these figures will be noted under their respective headings.

In the meantime, the following tables of the total imports and exports in 1913 and 1921, of four important articles in each class of trade, may be of value as giving some idea of the industry as a whole.

TOTAL IMPORTS INTO THE UNITED KINGDOM OF PHOSPHATE OF LIME AND ROCK PHOSPHATE, RAW GUANO, NITRATE OF SODA, AND BONES FOR MANURE (TONS).

Source.	1913.	1921.
Empire	30,078	26,831
Foreign countries	716,097	422,333
Total	746,175	449,164

TOTAL EXPORTS OF SUPERPHOSPHATE, BASIC SLAG, SULPHATE OF AMMONIA, AND GUANO AND COMPOUND MANURES, INCLUDING BONE MEAL AND OTHER MANUFACTURED FERTILIZERS, THE PRODUCE OR MANUFACTURES OF THE UNITED KINGDOM (TONS).

Destination.	1913.	1921.
Empire	96,821	31,025
Foreign countries..	602,973	126,117
Total	699,794	157,142

§ 2.

The chief fertilizers manufactured in the United Kingdom may be stated as sulphate of ammonia, superphosphate of lime, and basic slag, though certain quantities of such articles as fish meal, meat meal, ground dried blood, shoddy, etc., are produced as the by-products of the industries concerned.

It is natural enough that the works producing fertilizers should be fairly well distributed throughout the country. Every town of consequence has its gas-works, and the majority of these either produce sulphate of ammonia or sell their liquors to a near-by tar distiller or sulphate works where they are worked up. In addition, coke oven works are found in the principal colliery districts. The manufacture of bone manures goes along with that of glues and gelatines, and an

important section of this trade is located in the Midlands, though works are also found all over the country, while basic slag is, of course, the monopoly of the iron and steel areas. Factories are set up for the manufacture of other classes of manure as local resources offer raw material. Fish meal works are in or near Grimsby, for example, while shoddy is in the nature of things chiefly the product of Yorkshire and its woollen mills.

§ 3.

It may be taken that the merchant plays his part in the distribution of the products of Continental manure factories, and in the import of articles such as nitrate of soda and potash salts, where the United Kingdom is almost entirely dependent on outside sources of supply.

This state of affairs was, perhaps, even more marked before the War, as during and since the War period a tendency towards grouping has shown itself on the part of the manufacturers, notable instances being those of sulphate of ammonia and bone products. This grouping tendency is, doubtless, cutting down selling costs and increasing the strength of the firms grouped, and it is to be expected that this will lead to the expansion of their own selling organizations by the manufacturers, but we think it is to be anticipated that a certain amount of the export trade will remain in the hands of the merchant community, while the import end will, in our view, probably remain under the same control.

§ 4.

We will now consider the various fertilizer products together with such statistics as are available in regard to them.

It will be convenient for this purpose to arrange them under broad group headings as follows:

Phosphatic manures. Nitrogenous manures. Potassic manures.
Compound manures.

and we will endeavour to give fairly full particulars of the most important in each group, together with a short note regarding those of less importance from the commercial point of view.

It is not, of course, within our province to go closely into the details of the manufacturing processes, but in so far as they have a bearing on other branches of the chemical industry, a few words in connection with the manufacture of one or two articles may be of value.

§ 5.

PHOSPHATIC MANURES.

The articles of most importance in this class are superphosphate of lime, commonly abbreviated to "superphosphate," or even "super," and basic slag.

The former is produced by treating rock phosphate with sulphuric acid, and, in spite of the lack of phosphatic raw material in this country, England

managed to build up an industry of considerable importance, which reached a production of over 800,000 tons in the year 1913. The output of superphosphate, however, declined to some 380,000 tons in 1920, and at the present time the industry is going through a severe crisis due to competition from countries which are either more favourably placed in respect of raw material, or in which costs of production, particularly labour costs, are lower because a lower standard of living prevails.

The following table shows very clearly the decline in our export trade; there was a slight recovery in 1922, when nearly 6,000 tons were exported.

EXPORTS OF SUPERPHOSPHATE, THE PRODUCE OR MANUFACTURES OF THE UNITED KINGDOM (TONS).

Destination.	1913.	1921.
Empire	27,102	3,141
Foreign countries	36,378	325
Total	63,480	3,466

Britain's standing as a producer of sulphuric acid of course had its effect on the growth of this industry, and our production of superphosphate in 1913 is stated to have been 820,000 metric tons out of a world's total of 11,068,616 metric tons, while the corresponding figures for 1921 are 388,000 and 6,607,136 metric tons respectively. The other raw material need of the industry, the raw phosphate rock, may be taken as being filled almost entirely by imports.

Phosphates have been found in England at Ipswich, Cambridge, Bedford, etc., and in Wales, but in normal times these cannot be worked competitively, and we imported, in 1913, 539,016 tons of phosphate of lime and rock phosphate, and in 1921, 370,143 tons under the same heading, while in addition 25,548 and 8,465 tons of raw guano were imported in these years, and much of this was probably used for the manufacture of superphosphate.

It may be interesting to observe that in the case of rock phosphate, etc., named above, only a little more than 1 per cent. was imported from Empire sources in 1913, though this figure was improved in 1921 to about 5 per cent. by imports from Nauru and the Seychelles. The chief sources of supply in both years, however, were French Possessions and the United States.

We have treated the natural phosphates as the chief raw material need of the industry; formerly fair quantities of bones were imported into the United Kingdom, but the import has declined and the amount now used in superphosphate manufacture is negligible. The United Kingdom, as we have seen, may be considered a producer and exporter of superphosphate, and it was not considered worth while to give the product a separate heading on the imports list in 1913. In 1921, however, superphosphate appears as a separate item, and the imports are given as 42,665 tons, the greater part of which came from Belgium.

We will now consider the second fertilizer named in this group. Basic slag, as is well known, is a by-product from the manufacture of steel, and, like certain other materials of a chemical nature, was regarded as so much waste matter when first produced. Gradually, however, after various experiments and trials, it assumed a position of importance in the fertilizer world, and its consumption

increased from year to year, since it forms a cheap source of phosphoric acid, while its content of silica and lime renders it specially suitable for meadows and sandy soils which are poor in lime.

The Continental names for this fertilizer are "Scories Thomas," or "Scories de Déphosphorization," and, taken together, they really epitomize the history and the source of the material, which is a by-product formed in the course of the process first carried out by an Englishman, Sydney Gilchrist Thomas, in close association with his cousin, Percy Gilchrist, for the conversion into steel of iron ores which contain a high percentage of phosphorus. The slag as produced is a hard product in lumps (or blocks, if it is allowed to solidify in the trucks into which it goes on leaving the converter), and the manufacture, from a fertilizer point of view, consists merely in first breaking the material, and removing pieces of iron which occur in it, then milling it to a fine powder and packing this for delivery.

EXPORTS OF BASIC SLAG, THE PRODUCE OF THE UNITED KINGDOM.

	1913.		1921.	
Destination.	*Tons.*	*Value* (£).	*Tons.*	*Value* (£).
New Zealand ..	19,793	44,801	985	4,964
Canada	4,277	7,802	1,999	5,997
British Guiana	1,200	2,842	595	5,293
Other British possessions	8,841	16,177	414	1,751
Total to Empire	34,111	71,622	3,993	18,005
Russia ..	27,159	46,517	—	—
Sweden	13,632	21,623	—	—
Norway	9,392	15,247	—	—
Denmark, including Faroe Islands ..	10,787	17,547	—	—
Germany	7,932	10,517	—	—
France ..	26,995	29,587	1,350	1,555
Spain ..	4,902	7,332	500	1,925
Italy ..	18,234	28,715	—	—
United States of America	6,774	11,855	—	—
Other foreign countries	9,459	9,212	1	7
Total to foreign countries	135,266	198,152	1,851	3,487
Grand total	169,377	269,774	5,844	21,492

The United Kingdom is a producer of basic slag of some importance, but according to the figures available forms a fourth to Germany, France, and Belgium. The production figures give 404,000 metric tons to the United Kingdom in 1913, while Germany, in that year, produced the tremendous total of 2,250,000 metric tons. Our basic slag production for 1921 is given as 210,000 metric tons, and it may be remarked that practically every other country of which particulars are available produced even less proportionally to its figure for 1913. No deduction can, of course, be drawn from these figures as to the state of our steel industry; our production of basic slag is relatively small because we make chiefly high-grade

acid steel, but Continental steel works have to use comparatively low-grade iron ores and, consequently, use the basic steel process.

England has imported for a long time past quantities of basic slag, and the quantity for 1921, 44,354 tons, is a few thousand tons less than that for 1913, 51,133 tons, while in 1922, for which year statistics have come out since this book was started, the total quantity is 72,093 tons. The bulk of these imports in each year noted is from Belgium.

The table in the Customs returns is so interesting, as showing what has happened in the case of at least one of our considerable exports—the value of home produced basic slag exported in 1913 was £269,774—that we have thought it well to give it in its entirety on p. 84 for the two years we are considering.

It is evident from this table that in the last few years the bulk of the basic slag produced in the United Kingdom and of that imported has gone into domestic consumption.

The only other phosphatic manures that we need treat here are bone meal and dust, or flour. As we have indicated above, the importation of bones for making manure is declining. The table below gives details of the importation during 1913 and 1921, and the latest figures available show a total import of some 7,000 tons in 1922, and 8,000 tons in 1923.

IMPORTS INTO THE UNITED KINGDOM OF BONES FOR MANURE (TONS).

Source.	1913.	1921.
Empire	17,052	6,662
Foreign countries	23,633	8,073
Total	40,685	14,735

The Empire supplies a considerable part of our needs in this direction, British India, in point of fact, being the largest individual supplier.

We have not succeeded in tracing any production figures for this country of any bone fertilizers.

To conclude this section mention may be made of the item in the trade returns: compound manures, including bone meal and other manufactured fertilizers. The quantity returned, as imported under this heading in 1921, was approximately 21,000 tons, of which India was a notable supplier.

Bone fertilizers are exported in small quantities. It may be added that the bone fertilizer production of the United Kingdom is now largely in the hands of one concern, British Glues and Chemicals, Ltd., an amalgamation of some of the chief firms in the industry, which was arranged and publicly capitalized shortly after the War.

§ 6.

NITROGENOUS MANURES.

We have now to consider this class, of which sulphate of ammonia and nitrate of soda are the most important members. The former is of chief interest in the United Kingdom, as being entirely home produced from start to finish, and we will therefore consider it first.

Sulphate of ammonia, for use on a large scale as a fertilizer, originated as a gas works product. In the distillation of coal part of the nitrogen which it contains passes into the gas in the form of ammonia, which is removed from the gas by washing it with water. From the resultant "gas liquor" by further treatment is obtained ammonium sulphate.

The recovery of the ammonia produced in this purification of coal gas engaged the attention of gas engineers from the beginning of the gas industry, but it was much later that the product from coke ovens and other sources was recovered. In 1913 our sources of sulphate of ammonia were, in order of importance, gas works, coke oven works, shale works, producer gas, etc., works, and iron works, and out of a world production of 1,378,917 metric tons, the United Kingdom was responsible for 438,923 metric tons, being second only to Germany, which produced 549,000 metric tons of by-product ammonium sulphate. This position, however, was unfortunately not maintained, the corresponding figures for 1921 being:

Germany, 880,000; the United States, 325,226; the United Kingdom, 256,289.

In this period, also, the production of Canada had increased by more than 50 per cent., and that of Australia had more than doubled.

Sulphate of ammonia is certainly one of our chief articles of export from the fertilizer point of view; indeed, on a value basis it is easily the most important, the 1913 total amounting to £4,390,547. The comparative particulars for the two years under review are as follows:

EXPORTS OF SULPHATE OF AMMONIA, THE PRODUCE OF THE UNITED KINGDOM (TONS).

Destination.	1913.	1921.
Empire	20,529	16,311
Foreign countries	302,525	112,182
Total	323,054	128,493

It is noteworthy that in the last two years our exports have materially increased; in 1922 the total export was over 144,000 tons, and in 1923 it exceeded 253,000 tons.

If the production figure for 1913 is correct, as there is no reason to doubt, we exported nearly three-quarters of our total production, and our best customers in 1913 were Japan, Spain, Java, and the United States, the Empire only accounting for quite a small proportion of our output. The markets in 1921 were different however, the United States taking nothing and Japan very little compared with the pre-war year; our largest buyers were Spain, France, and Java, and the Empire took a much greater proportion of the total. It is satisfactory to note that in 1923 our export to Japan increased to 60,000 tons, as compared with 7,000 tons in 1921, and our export to Spain increased from 38,000 tons in 1921 to 65,000 tons in 1923.

Sulphate of ammonia was not entered separately in the import returns for 1913, but in 1921 only 2,320 tons were imported; it is interesting, however, to observe that part of this came from Canada.

We must now consider nitrate of soda, another highly important nitrogenous

manure. This country is entirely dependent on outside suppliers for its nitrate, and, indeed, there is at present no known source of supply for natural sodium nitrate within the Empire. It will be as well to give the full imports table for this product in the year under review.

IMPORTS OF NITRATE OF SODA INTO THE UNITED KINGDOM (CWTS.).

Source.	1913.	1921.
Norway	15,620	14,564
France	14,460	220
Chile	2,726,800	1,097,330
Other foreign countries	61,640	4,299
Total	2,818,520	1,116,413

It will be observed that the imports from Norway of hydro-electric nitrate have kept remarkably level, but all other supplies have fallen off considerably. The material from other foreign countries is probably Chilean in origin. It must be added that these figures include nitrate used for the manufacture of nitric acid, but as by far the most important use of the product is as a fertilizer, we have thought it well to deal with it in this section.

It may be stated that in both years under review the United Kingdom took roughly one-twentieth of the Chilean output of nitrate of soda; re-exports are shown in the table below.

This trade fell away badly in 1921, but, according to the latest available statistics, it revived considerably in 1922, falling away again in 1923. The figures up to 1922 are shown in the following table, which we have thought it well to give in full:

RE-EXPORTS OF NITRATE OF SODA FROM THE UNITED KINGDOM (CWTS.).

Destination.	1913.	1921.	1922.
Channel Islands	3,580	121	796
Mauritius and Dependencies	6,240	5,800	—
British India	4,660	1,803	18,579
Australia	1,000	50	27,243
British West Indies	14,260	563	2,663
Other British possessions	10,100	457	8,109
Total to Empire	39,840	8,794	57,390
Russia	2,400	105	—
Sweden	140	—	21
Belgium	—	—	139,349
French West Indies	20,820	—	—
Spain	114,320	140	46,165
Canary Islands	14,940	3,651	5,068
Other foreign countries	20,860	2,769	2,460
Total to foreign countries	173,480	6,665	193,063
Grand total	213,320	15,459	250,453

It may be added, for purposes of comparison, that the grand total for 1919 was 4,415,680 hundredweights, and for 1920, 950,163 hundredweights.

As we have stated above, this country is entirely dependent upon imported nitrate of soda.

It would appear that the chief hope of getting Empire supplies of nitrogenous fertilizers to replace foreign sources lies in employing synthetic processes for utilizing atmospheric nitrogen. It is well known that Germany has so securely established her manufacture of synthetic ammonia and nitrates by the Haber-Bosch and other processes that she is independent of outside supplies, and it is satisfactory to note that an important plant for nitrogen fixation in the United Kingdom is said to have now reached the producing stage.

Other nitrogenous fertilizers of less importance are nitrate of lime, nitrolim or cyanamide, castor meal, ground dried blood, meat meal, horn meal, shoddy, etc.

The first two of these are almost entirely imported, Norway being the chief producer of nitrate of lime. No figures are available for 1913, but the imports shown in 1921 are: Nitrate of lime, 35,601 hundredweights; nitrolim, 56,880 hundredweights.

Of the other fertilizers named, castor meal is produced in a few works in this country and is in some demand on the Continent. The other products are produced here and, with the probable exception of shoddy, both imported and exported. Separate statistics are not, however, available, nor do we consider the relative amount of trade in these articles sufficiently important to warrant our devoting further space to them.

§ 7.

Potassic Manures.

The chief fertilizers of this class are kainite, sylvinite, muriate of potash, etc. So far as this country is concerned the production of potassic manures may be taken as practically non-existent, though blast furnace flue dust came into some prominence during the War as a source of potash.

The chief sources of supply are Germany and Alsace-Lorraine, the former, in 1921, producing 921,147 metric tons against 146,355 metric tons from the latter. Details of the amount of potash salts for manurial purposes imported into the United Kingdom in 1913 can be obtained from the official German export returns, and it is seen that we imported roughly 2½ million hundredweights of crude salts, or the equivalent of some 460,000 hundredweights of pure potassium oxide (K_2O). In 1921 the total imports of kainite and other potash fertilizer salts not elsewhere specified, amounted to 967,157 hundredweights, of a value of £200,926. Of this total Germany contributed 607,648 hundredweights, valued at £118,664, and the total from Empire sources was only 36 hundredweights, of a value of £10. It would appear probable that for some time to come the United Kingdom will be dependent upon extra-Empire sources for her supplies of potassic fertilizers.

§ 8.

Compound Manures.

Generally speaking, compound manures consist of mechanical mixtures of materials containing the fertilizing elements, phosphoric acid, nitrogen, and potash, prepared with a view to obtaining a " complete manure " for any given soil or crop. This branch of the industry is of some importance in this country, though the chief demand is probably local. No statistics are apparently available as to the production, while the external trade statistics are under the composite heading of " Guano, Manufactured, and Compound Manures, including Bone Meal and other Manufactured Fertilizers," and it is not possible to state separate amounts for the various headings.

Import statistics are not given for the pre-war period, but in 1921 the total brought into the country was 21,010 tons, of which 13,400 tons came from India, and may be reasonably taken as bone meal.

The chief reason for including this section in the present volume, however, is the export trade under this heading; the value in 1913 was £926,656, and the tonnage in the years under review was as follows:

Exports of Guano, Manufactured, and Compound Fertilizers, etc., the Produce or Manufactures of the United Kingdom (Tons).

Destination.	1913.	1921.
Empire	23,633	7,580
Foreign countries	128,804	11,759
Total	152,437	19,339

The total export increased to 41,419 tons in 1922, but still leaves much to be desired.

§ 9.

Re-Exports.

The export trade in home produced or manufactured fertilizers is, undoubtedly, by far the most important part of the fertilizer trade of the United Kingdom, but a few particulars regarding re-exports may not be out of place. The chief article in this connection is, of course, nitrate of soda, with which we have already dealt, but a certain amount of re-export is noted in the Customs returns in most of the fertilizers that we have enumerated as being imported into the country.

The trade as a whole, apart from nitrate of soda, amounted in 1921 to £38,124, and it is scarcely worth while to give detailed statistics. The most notable headings, however, are raw guano, of which 3,315 tons were sent out in 1913, and 98 tons in 1921; phosphate of lime and rock phosphate, in which the corresponding figures are 11,622 tons (practically all to New Zealand) and 18 tons;

bones for manure, 2,553 tons (U.S.A. 1,397 tons) and 936 tons; and basic slag, of which 3,727 tons were re-exported in 1913 (3,366 tons to New Zealand) and 186 tons in 1912.

§ 10.

It will have been realized from the foregoing particulars that the export trade in fertilizers is of considerable importance to this country, and consideration of the statistics one by one will have shown that it was in 1921 suffering from extreme depression. The position in 1922 was better, and, although money values are deceptive, the following particulars of the total exports (including re-exports), under all fertilizer headings, in the Customs returns, may be of some interest:

Year.	£.
1913	5,941,660
1921	3,061,778
1922	3,119,725

In considering these figures, the difference in the value of money to-day, as compared with 1913, must be borne in mind, and it will then be realized how much ground we have to regain. The solution of the problem is not entirely in the hands of the fertilizer trade itself, since some fertilizers are the by-products of other industries, but fertilizer makers are doing all in their power to keep their works going until better times return for the industry.

CHAPTER VII

THE UNITED KINGDOM: FINE CHEMICALS

§ 1.

WE have given as full an account as is possible, in the very limited space of this volume, of heavy chemicals, but it has necessarily been very brief and incomplete. We now propose to deal with fine chemicals, and in making our classification we have been forced to touch the vexed question of "What is a fine chemical?" We are fully aware that it will be impossible for us to adopt a classification which will satisfy all claims, since, although there is a large class of chemicals universally recognized as fine chemicals, there exists a small number of chemicals which may be said to lie on the border-line demarcating heavy from fine.

Fine chemicals may be divided into the following main groups: synthetic organic dyes and intermediate products; pharmaceutical and photographic chemicals; analytical reagents; synthetic perfumes and essences; rare earth compounds; alcohol derivatives and esters.

A separate section of this book deals with dyes and intermediates and the present section will be devoted to the remaining fine chemical groups.

Prior to 1914 the fine chemical industry was practically a monopoly of Germany, although several British firms possessed an international reputation

for some of their products. It is difficult in the space at our disposal to do justice to the subject of British effort in the field of fine chemical manufacture. In order that the position may more easily be realized it must be remembered that the War cut off entirely our normal supplies of all kinds of fine chemicals. Beyond the stocks in the country we had no means of obtaining supplies of drugs such as aspirin; of anæsthetics such as novocaine; of remedies such as salvarsan; of synthetic photographic chemicals which were vital to aerial photography and for X-ray work in the hospitals; of synthetic tannins required in the leather industry; of analytical reagents for chemical analysis in the great steel works and in practically every other industry; and of a variety of other fine chemicals necessary for research work and in industry.

Fine chemical manufacture was hurriedly undertaken in Great Britain, under most adverse conditions in respect of buildings, plant, and processes, and very substantial progress was made. In a few months British salvarsan and salicylic acid were on the market; other drugs soon followed, and before hostilities ceased there was scarcely a synthetic drug of real importance that was not made in this country in sufficient quantities and, in many cases, with a margin for export. The same was true of the synthetic photographic chemicals, amidol, metol, paramidol, and glycin, and at the present time British photographic chemicals are second to none in quality. Of the synthetic perfumes and flavourings a certain number were made here before the War, but since then production has been largely developed of such bodies as heliotropine, ionone, and vanillin, of amyl acetate, butyrate, and salicylate, benzyl acetate, chloride, and benzoate, butyl acetate and butyrate, ethyl aceto-acetate, butyrate, and chloride, and methyl acetate and salicylate, to mention only a few of the commoner ones.

Space does not permit of more than brief mention, but we may note the British manufacture of such synthetic tannins as syntan, maxyntan, paradol, etc., which replaced the German neradol and ordoval; of gallic acid for use in dye manufacture, for ink-making, and for ferro-gallic paper, etc.; of the hydrosulphites and sulphoxylates for use in the textile trades for indigo-dyeing and for stripping colours from dyed fabrics, etc.; of lactic acid, so important in the leather industry and in dyeing, etc.; of barium compounds for many purposes; of artificial peroxides and persalts for bleaching, etc.; of plastics such as triphenyl phosphate for use in the celluloid industry; of analytical reagents and research chemicals; of thorium nitrate, essential to the gas-mantle industry; of saccharin and of chloramine, a valuable disinfectant; of a whole range of organic accelerators for rubber vulcanizing; of medicinal glycerophosphates; of ammonium phosphate for fireproofing purposes, and of many other compounds too numerous to mention.

When it is remembered that Germany, with over forty years' experience of the manufacture of fine chemicals in elaborate plant working on mass production scale, and with all the strength of the complete internal organization known as the I.G. (Interessen Gemeinschaft), has, since the War, made strenuous attempts to regain her former supremacy in the world markets, the greatest credit is due to the British fine chemical makers for the advances which they have made during a period in which they have been hampered by general trade depression, by the existence of large stocks imported into the country while a

measure of protection was under discussion, and by the continued depreciation of the German exchange. In contrast to the German organization the British industry is in the hands of a number of individual firms, and the industry has passed through very critical times alleviated in part by the protection afforded by the Safeguarding of Industries Act, 1921. Since the passage of the Act much capital has been invested in new buildings and plant, and the range of products has been widely and continuously extended. As an instance of this, a firm making some seventy fine chemicals in 1913 is now in a position to supply about 1,200.

A recent development of the fine chemical industry is the production by three or four firms of insulin, the specific for diabetes recently prepared by Banting and Best, of Toronto. It is stated in the Report of the Medical Research Council for 1922-23 that British production is now sufficient to meet the whole home demand and to allow of a growing export to other parts of the Empire and to foreign countries.

This industry, in which we have made and are making such great progress, ought at all costs to be maintained, so that never again can there be any possibility of Britain's being dependent upon outside supplies of products essential to her well-being. Great wars in the future will, no doubt, require explosives as they have done in the past, but it will not only be a question of explosives. Future wars must, undoubtedly, tend to become more and more chemical in their conduct, and it is only by maintaining a great fine chemical and dye industry that Britain can keep abreast, or preferably in advance, of other countries in the intricacies of chemical warfare and defence.

Again, quite apart from the actual military side of war, there is the vital problem of national health. Every endeavour must be made to render the Empire independent of foreign produced chemicals which are necessary for medicinal purposes.

§ 2.

We will turn now to a brief survey of the fine chemicals for which import and export figures are available in the trade returns. We have divided the compounds into two groups, organic chemicals and inorganic chemicals, the former of which will be discussed first. Dyes and intermediates have been dealt with in a previous chapter, and many more compounds which fall into the class of pharmaceutical chemicals will be dealt with in the following chapter as drugs and medicinal chemicals.

Of all compounds to be discussed in this section, with one exception—namely, that of certain esters—statistics are given for the year 1921 only, since prior to 1920 the substances have been included under general classifications in such a manner as to render analysis impossible. For this reason, then, esters will be discussed separately, but even so, no statistics of exports of British manufactured esters are available for 1913.

§ 3.

The first group of compounds for which import and export statistics are available consists of the products, ethyl acetate, ethyl butyrate, ethyl chloride, sulphuric ether, ethyl bromide, and ethyl iodide. As stated above, these products are now United Kingdom manufactures, and the amount of business done both in imports and exports is really not very great, although it would naturally be expected that the quantities involved in such products as those under discussion would be very much smaller than in the case of heavy chemicals. As far as imports and exports are concerned, there is no trade in ethyl bromide and ethyl iodide, but we give below such statistics as are available:

EXTERNAL TRADE OF THE UNITED KINGDOM IN ESTERS.

Product.	Source or Destination.	Imports. 1913 (Lbs.).	Imports. 1921 (Lbs.).	Exports. 1913 (Lbs.).	Exports. 1921 (Lbs.).	Re-Exports. 1913 (Lbs.).	Re-Exports. 1921 (Lbs.).
Ethyl bromide	Empire	Nil	Nil	—	—	—	—
	Foreign countries	59	8	—	—	—	—
	Total	59	8	—	—	—	—
Ethyl iodide	Empire	Nil	—	—	—	—	—
	Foreign countries	3	—	—	—	—	—
	Total	3	—	—	—	—	—
Ethyl acetate	Empire	Nil	1	—	3,392	21	—
	Foreign countries	3,769	161	—	3,229	32	—
	Total	3,769	162	—	6,621	53	—
		(Gallons).	(Gallons).		(Gallons).	(Gallons).	
Ethyl butyrate	Empire	Nil	Nil	—	82	2	—
	Foreign countries	221	72	—	3	Nil	—
	Total	221	72	—	85	2	—
Sulphuric ether	Empire	Nil	Nil	—	847	302	—
	Foreign countries	513	12	—	679	152	—
	Total	513	12	—	1,526	454	—
Ethyl chloride	Empire	Nil	Nil	—	167	26	Nil
	Foreign countries	95	9	—	147	11	300
	Total	95	9	—	314	37	300

The destinations are in no case given in detail, and only in the case of ethyl acetate and ethyl butyrate are the countries of origin specified. Practically the

whole of our imports of these two compounds in 1913 were of German origin, and in 1921 of United States origin. Our exports in both years were about equally distributed between the Dominions and foreign countries.

It now only remains to give a brief account of the uses of these esters. Ethyl acetate is used chiefly for the manufacture of other esters and as a solvent for nitrocellulose. It has a pleasant fruity odour, and is used as a flavouring matter, as is also ethyl butyrate. Ethyl chloride is a solvent and ethylating agent for organic substances, a refrigerating agent, and a local anæsthetic. It has a boiling point of only 12° C.; in other words, it is a gas at ordinary temperatures.

Sulphuric ether is the ordinary ether used for surgical purposes. It is manufactured in considerable quantities from alcohol and sulphuric acid, and must be in a state of great purity when used as an anæsthetic. It is also used as a solvent. Ether is very highly inflammable at ordinary temperatures, and the utmost care is necessary in dealing with it. Ethyl bromide and iodide are chiefly of importance in connection with synthetic organic compounds.

We now turn to the other organic compounds which we propose to discuss in this chapter—formic acid, formaldehyde, and lactic acid. The following table shows the import and export returns for the three substances:

EXTERNAL TRADE OF THE UNITED KINGDOM IN CERTAIN FINE CHEMICALS.

Product.	*Source or Destination.*	*Imports.* 1921 (*Lbs.*).	*Exports.* 1921 (*Lbs.*).	*Re-Exports.* 1921 (*Lbs.*).
Formaldehyde	Empire	253,554	78,970	30,829
	Foreign countries ..	801,637	110,512	113,378
	Total	1,055,191	189,482	144,207
		(*Cwts.*).	(*Cwts.*).	(*Cwts.*).
Formic acid	Empire	Nil	56	3
	Foreign countries ..	6,546	223	Nil
	Total	6,546	279	3
Lactic acid	Empire	Nil	468	135
	Foreign countries ..	3,163	116	23
	Total	3,163	584	158

Britain imports very considerable amounts of formaldehyde, the quantity during 1920 amounting to 4,172,802 pounds, of which by far the largest supplier was the United States, with over 3½ million pounds. In 1921 our imports had fallen, but the total imports still exceeded 1 million pounds; the United States was again our largest supplier, with 422,241 pounds, but Germany also supplied 236,057 pounds, while Canada exported to this market 253,554 pounds. In 1922 the total imports fell to 10,289 pounds.

Of our exports to foreign markets 36,960 pounds were shipped to France out of a total of 110,512 pounds. The exports to British Possessions have no destinations specified, and in 1922 the total exports amounted to only 1,504 pounds, equally distributed between foreign and Empire buyers. Our re-export trade in formaldehyde assumed considerable proportions in 1920 and 1922, in the latter year France and the United States being the biggest buyers, with 26,505 and 10,400 pounds respectively. Here, again, the actual destinations to Imperial markets are not given.

Formaldehyde is manufactured from methyl alcohol, although other processes have been proposed. It is used in great quantities as a disinfectant, and is also used as a preservative for the crude materials used in tanneries, etc., and in products such as gums and glue. It finds application also in the manufacture of rubber goods, in the leather trade, and in photography, but the greater part of the world's production of formaldehyde is consumed in the manufacture of formaldehyde condensation products with phenolic bodies or casein products. These products, first introduced as electrical insulators, have found extensive employment in the manufacture of artificial amber, ivory, bone, etc.

Formic acid is a compound of growing importance in modern industrial processes, much more so, in fact, than is indicated by the statistics. Imports into the United Kingdom were almost entirely of German origin, and those entered as from the Netherlands, the actual quantities being: Germany, 4,193 hundredweights, and the Netherlands, 1,925 hundredweights. In 1922 the imports had increased to a total of 16,415 hundredweights, of which Germany supplied 10,821 hundredweights and the Netherlands 5,083 hundredweights. As will be seen from the table given above, exports of British formic acid are inconsiderable, as are also re-exports of foreign merchandise.

Formic acid is chiefly employed in the dyeing industry, especially in wool-dyeing, and also in tanning. A certain amount is also used as a preservative.

Lactic acid is manufactured in Britain in considerable quantities by the lactic fermentation of sugar derived from such raw materials as maize. Plant capacity is sufficient to produce a large surplus for export, but English makers are at a disadvantage inasmuch as America can obtain molasses and maize at low prices, while in Germany beet molasses and potato starch are normally cheap. In 1921 and 1922 our imports were all of foreign material, amounting to 3,163 hundredweights in 1921, and 7,911 hundredweights in 1922. The bulk of these imports was of German origin, 2,635 and 7,607 hundredweights being exported from that country to England in the years in question. Our exports were mainly to British Possessions, the actual destinations not being specified.

Lactic acid is extensively used in wool-dyeing, and in the leather trade to remove calcium salts from the hides. It is also used in the confectionery trade. Antimony lactate and certain other lactates are used in dyeing and printing calico.

The last two organic compounds of which statistics are available are salicylic and pyrogallic acids, both of which are of great importance industrially. The Customs statistics are given on p. 96.

EXTERNAL TRADE OF THE UNITED KINGDOM IN CERTAIN PHENOLIC ACIDS (LBS.).

Product.	*Source or Destination.*	*Imports.* 1921.	*Exports.* 1921.	*Re-Exports.* 1921.
Salicylic acid	Empire	Nil	46,857	650
	Foreign countries	45,249	11,751	100
	Total	45,249	58,608	750
Pyrogallic acid	Empire	4,860	700	477
	Foreign countries	15,108	1,129	359
	Total	19,968	1,829	836

Salicylic acid is, of course, made here, and there is a considerable margin for export.

Taking our imports of salicylic acid over a period of years, it is found that Germany is the most consistent supplier. In 1920-22 she exported to the English market 21,769, 25,626, and 30,806 pounds respectively. France and America were also extensively engaged in exporting salicylic acid to our market. In 1920 Britain imported 176,590 pounds of the American product, imports from this source declining to 12,618 pounds in 1921, and 3,747 pounds in 1922. France, on the other hand exported to us 30,665 pounds in 1920, 4,930 pounds in 1921, and 29,892 pounds in 1922.

To turn now to exports, in 1920 Britain exported the great quantity of 302,015 pounds, out of which 244,300 pounds was destined for foreign countries and 57,715 pounds for British Possessions. In 1921, however, our total exports had fallen to 58,608 pounds, of which the Dominions purchased roughly four-fifths. Whereas, in 1920, Japan purchased over 100,000 pounds from this country, in 1921 her purchases were only 320 pounds. As regards our exports to the Empire, these have remained fairly steady, as will be seen from the following returns: 1920, 57,715 pounds; 1921, 46,857 pounds; 1922, 60,454 pounds. Australia is our best customer for salicylic acid, and during the three years 1920 to 1922 she purchased 24,920, 30,954, and 39,521 pounds respectively, apparently a steadily increasing demand being maintained. In this connection it will be interesting to see the figures for 1923 when they become available. To sum up, it would appear that Britain has practically lost her foreign markets for salicylic acid, but that in the Empire markets she is still able to compete. The re-export business in salicylic acid is not of great importance, since in the year 1920 the total re-exports were only 15,502 pounds.

Salicylic acid is manufactured from phenol by subjecting sodium phenate to the action of carbon dioxide gas. It is a highly important compound from the point of view of its relation to medicinal preparations alone. Aspirin, or acetyl salicylic acid, is manufactured from salicylic acid by acetylation with acetyl chloride or some other suitable acetylating agent. Salicylic acid is extensively employed as an intermediate in the dyestuffs industry and for the manufacture

of flavouring essences. Methyl salicylate is artificial oil of wintergreen, and there are many other aliphatic salicylates of commercial value.

Pyrogallic acid alone of the organic compounds in this chapter remains to be discussed. It is made from gallic acid which is prepared from Chinese gall nuts, and there is plant capacity in the United Kingdom to meet the demand for all grades of gallic acid and for technical pyrogallic acid. From the Customs returns it is evident that the United States is now our greatest competitor in this product, her exports to the United Kingdom in the years 1920 to 1922 being 16,685, 14,460, and 18,428 pounds respectively. It is interesting to find that Canada also supplies this market to some extent. Our imports of pyrogallic acid, although not large, exceed our exports very considerably. The destinations of our exports are not specified in the statistics, and, as will be seen from the table we have given, our re-export trade is quite inconsiderable.

The consumption of pyrogallic acid, or trihydroxy benzene, industrially is chiefly in the field of photographic chemicals, in medicine, and in fur-dyeing.

§ 4.

In the previous section we have dealt with those organic chemicals which can be considered fine chemicals, and of which official statistics are available. We shall now review in a similar manner the inorganic fine chemicals. This group consists of thorium nitrate, silver nitrate, tin compounds, bromine and bromides, and iodine and iodides. With reference to the last-named chemicals, separate statistics are given for potassium iodide, which will, therefore, be discussed on its own merits.

We would here remark that the inorganic fine chemicals under discussion are equally as important, from many points of view, as those of the organic group, silver nitrate and potassium bromide being used in large quantities industrially. There is only one rare earth compound, thorium nitrate, which is sufficiently important to warrant particular attention, though mention should be made of cerium nitrate and cerium fluoride.

Thorium nitrate is manufactured in England, the raw material usually being monazite sand, and can be produced in quantities sufficient to meet all home demand with a surplus for export. Monazite also contains numerous other rare earth compounds, and the separation and purification of the thorium salt is an intricate and lengthy operation, far too technical to discuss in this book. It is of very great importance industrially, in that it is used in relatively large quantities together with a much smaller amount of cerium nitrate, in the manufacture of gas mantles. We give below the import and export statistics for thorium nitrate.

External Trade of the United Kingdom in Thorium Nitrate (Lbs.).

Source or Destination.	*Imports.* 1921.	*Exports.* 1921.	*Re-Exports.* 1921.
Empire	Nil	2,045	Nil
Foreign countries	149,493	10,573	4,468
Total	149,493	12,618	4,468

We imported from America 112,795 pounds, out of the total amount of 149,493 pounds of the finished compound; the rest, with the exception of 4,698 pounds, was of German origin. Since we are capable of manufacturing pure thorium nitrate in this country, this is yet another instance of importing goods in competition with the home produced article. The total exports of British made thorium nitrate, in 1921, were only 12,618 pounds, and the destinations were not specified.

We will now turn to the consideration of iodine and bromine compounds. With the exception of the small amounts of iodine which are obtainable from the kelp industry, to which we referred in the potassium compounds group, the United Kingdom has no native sources of supply of iodine. Further, we have no natural resources of bromine whatever.

Iodine occurs in very considerable quantities in the nitrate deposits of Chile, which constitute the chief source from which it is obtained. Even in the semi-purified condition, in which Chile saltpetre is exported to this market, the nitrate still contains a recoverable amount of iodine. A very large proportion of iodine and iodides are imported into this country in a finished condition, as the under-noted table will show.

EXTERNAL TRADE OF THE UNITED KINGDOM IN IODINE AND BROMINE COMPOUNDS.

Product.	*Source or Destination.*	*Imports.* 1921 (*Lbs.*).	*Exports.* 1921 (*Lbs.*).	*Re-Exports.* 1921 (*Lbs.*).
Iodine and iodides, excepting potassium iodide	Empire	577	18,378	Nil
	Foreign countries ..	622,257	108,882	50,856
	Total	622,834	127,260	50,856
		(*Cwts.*).	(*Cwts.*).	(*Cwts.*).
Potassium iodide	Empire	Nil	401	Nil
	Foreign countries ..	157	440	Nil
	Total	157	841	Nil
Bromine and bromides ..	Empire	Nil	652	55
	Foreign countries ..	9,882	108	34
	Total	9,882	760	89

Iodine itself is chiefly exported to the United Kingdom from Chile, although it has, in the past, been made in considerable quantity in Scotland from kelp. Taking our imports of iodine and iodides for the year 1921 out of the total of 622,257 pounds from foreign countries, no less than 478,604 pounds was imported from Chile, practically the whole of the balance coming from Java. Our imports from within the Empire were of no consequence, as will be seen from the above table.

Examining next the question of export of British produced iodine and iodides it is found that Russia, France, and the United States are the largest buyers in this

market, although in quantities of from 500 to 2,000 pounds, our exports are general to European markets as well as to Argentina and Brazil. In 1921 the following purchases were made by foreign countries from the United Kingdom: Russia, 12,320 pounds; Netherlands, 18,361 pounds; France, 32,111 pounds; United States, 21,034 pounds. Quite a large export trade with British Possessions is carried on also, our three best customers in this field being India, Australia, and Canada. Over the three years 1920 to 1922 India bought consistently from this country. An appreciable volume of trade in the export of foreign produced iodine and iodides was done over the period 1920 to 1922, chiefly with France and Italy, the latter country, however, making no purchase of re-export material in 1922. Re-export with the Dominions was non-existent.

Iodine is consumed in considerable quantities for the manufacture of iodides. It is used extensively for medicinal purposes and also in the manufacture of certain coal tar dyes. Iodine also finds application to some extent in the leather trade and in lithography.

Potassium iodide, perhaps the most important of the iodides, is not bought by Britain in large quantities. In 1922 there was no importation of this material and in 1921 only 157 hundredweights were entered; of this Japan supplied 63 hundredweights and France 36 hundredweights. As far as exports are concerned, Holland is our best market, although we have quite an extensive export trade in small quantities the world over. The demand for British iodide of potassium arises also in the Dominions, India being the largest purchaser among them; 125 hundredweights were exported to India in 1921, and 83 hundredweights to Australia. There were no re-exports of this compound in 1921.

Potassium iodide is manufactured by the action of iodine on caustic potash, a mixture of iodide and iodate being formed. The latter is reduced to iodide by another process. Potassium iodide is used in photography and in large quantities in medicinal preparations.

Bromine, like iodine, occurs in nature in considerable quantities in a state of combination, and is obtained to a great extent from the Stassfurt deposits. As has already been remarked, Britain has no native source of bromine and relies entirely on imports whether in the form of bromine itself or of bromides. It will be seen from the table of statistics above that in 1921 Britain imported 9,882 hundredweights of bromine and bromides, the whole being of foreign manufacture. Out of the total, 8,324 hundredweights were imported into this country from Germany, and it may be noted that in 1920, 5,200 hundredweights and in 1922 4,094 hundredweights were imported from the same source. Turning to the export of British produced bromides, the Customs returns are not very illuminating, since the actual destinations are not given either in the case of exports to foreign countries or to the Empire. All the information available is given in the table. The re-exports of bromine and bromides are insignificant.

Potassium bromide is the most important of the metallic bromides and is manufactured in a similar manner to the corresponding iodide, while its chief application, which is considerable, is photography, and it is used in quantity, medicinally, as a sedative. Bromine is used to some extent in metallurgy, and also in the manufacture of certain dyes, such as eosin, which

is tetrabromfluorescein. It is, of course, also used in the manufacture of bromides.

The last two inorganic fine chemicals with which we shall deal in this volume are silver nitrate and "tin salts." Silver nitrate is made in this country and certain salts of tin—*e.g.*, the chloride—are made also. Although tin salts might be considered sufficiently important to be worthy of more detailed entry in Customs returns, nevertheless, they are "lumped" under the heading given above, and we can only give the statistics relating to them in the form in which they are available:

External Trade of the United Kingdom in Silver Nitrate and Tin Salts.

Product.	*Source or Destination.*	*Imports.* 1921 (*Lbs.*).	*Exports.* 1921 (*Lbs.*).	*Re-Exports.* 1921 (*Lbs.*).
Silver nitrate	Empire	Nil	1,395	Nil
	Foreign countries ..	74,347	659	36
	Total	74,347	2,054	36
		(*Cwts.*).	(*Cwts.*).	(*Cwts.*).
Tin salts	Empire	Nil	1,217	Nil
	Foreign countries ..	1,261	118	Nil
	Total	1,261	1,335	Nil

It is unfortunate that no details of either export or import of the two compounds in question are available for the year 1913. In the case of silver nitrate it is evident that the United Kingdom is a buyer rather than a seller, although there is no valid reason why she should not be able to make sufficient to cover her entire needs. Silver nitrate may be made by dissolving metallic silver in nitric acid and crystallizing the salt, it being necessary, however, to remove any copper which may be present.

Germany supplies to this country the greatest proportion of our imports of silver nitrate, the amount received from her in 1920 being 50,250 pounds, and in 1921, 55,681 pounds. The Netherlands also shipped appreciable quantities to Britain, and in 1921 Czecho-Slovakia was responsible for 8,770 pounds. It is noteworthy that in 1922 Britain imported only 5 pounds of silver nitrate, while, on the other hand, her exports had increased in 1922 to 3,138 pounds, which is highly satisfactory. There have been no re-exports of silver nitrate, but there is quite a steady business in the home produced salt, chiefly with the Dominions. During the years 1920 to 1922 the exports to British India amounted to 1,031 pounds, 924 pounds, and 1,034 pounds respectively; Hong Kong was also a buyer of small quantities.

Silver nitrate is consumed mainly in photographic chemical manufacture, although it is also used medicinally as a cauterizing agent, and in the manufacture of marking inks and hair dyes.

The most important tin compounds industrially are the oxide and chlorides. Both stannous and stannic chlorides may be obtained by the action of hydrochloric

acid on tin. Stannic chloride is usually sold in solution, a liquid which fumes heavily in air. Tin oxide is mainly used in the enamel industry. Tin salts are used industrially in many ways, but chiefly for silk-weighting and in the dyeing industry.

In 1920 Britain imported 824 hundredweights of tin compounds from British Possessions, but in 1921 and 1922 none from Imperial sources. Our greatest supplier is Germany, while the Netherlands and the United States are also worthy of mention. Exports of British produced tin compounds, although quite considerable, particularly in 1921, have no destinations specified either in foreign countries or in the Dominions.

§ 5.

At the commencement of this chapter we emphasized the paramount necessity of supporting the fine chemical industry which has been established in this country. We have shown that an export trade in British fine chemicals does exist, and it is obvious that Britain is quite capable of producing from raw materials any or all of the products she requires. During the War the necessary plant was erected, and it should be our special care to see that it remains in operation on as large a scale as possible. The prosperity of a nation depends so much upon the national health that, for this reason alone, every nerve should be strained to supply from our own factories every chemical and drug necessary to maintain the highest possible standard of health.

National health and safety in time of war are, of course, the main considerations, but there is also the vital question of chemical research to be remembered. It can scarcely be denied that a system which educates the chemical student to a high standard of efficiency in the field of research, and at the same time forces him to depend upon foreign fine chemicals for that research, is by no means perfect. The modern chemical industry depends more and more on the works chemist for discovery and elaboration of new processes, and the necessary reagents should be obtainable from a source upon which the chemist may depend with certainty as and when they are required.

CHAPTER VIII

THE UNITED KINGDOM: DRUGS AND MEDICINAL CHEMICALS

§ 1.

THE manufacture of medicinal chemicals is even more vital to the strength and safety of the British Empire than that of the fine chemicals which we have reviewed in the previous chapter.

Drugs and their allied chemicals are merely a branch of the fine chemical industry, but as they are required every day in maintaining the health of the nation it is evident that at all costs we must prevent their monopoly from reverting to Germany. In developing a great fine chemical industry we are laying the founda-

tions of national defence, in that the plant used in the manufacture of fine chemicals may be converted to military use in time of war. In developing the manufacture of drugs and medicinal chemicals we are doing more than this; we are making the Empire independent of foreign countries for the supply of those drugs and antiseptics which are essential to modern medical practice and to the prevention of disease.

Like many of the compounds we have described in our chapter on fine chemicals, a great many synthetic drugs were exclusively manufactured in other countries before the War, but are now produced by British makers in considerable quantity and of a very high standard of purity. Such compounds as aspirin and phenacetin may be taken as examples of this type of drug. It has not been, however, in simple drugs only that the British fine chemical manufacturer has made such wonderful progress, but also in the production of the more complicated organic compounds, as a type of which we would instance salvarsan and other preparations which have followed it.

In the field of vegetable alkaloids the United Kingdom has long been established as a producer, and large quantities of quinine and morphine are manufactured here. It must be understood that the production of such alkaloids as morphine and cocaine is rightly very much hedged about by restrictions, and their manufacture and sale are permitted only under license.

To-day it would be possible easily to obtain every type of synthetic and natural drug required in the practice of medicine, from the Empire's resources. To name only a few which are now produced in Britain, there are the glycerophosphates of several metals, salol, orthocaine, aspirin, phenacetin, saccharin, urethane, etc. In the course of time, with judicious assistance, the manufacture of medicinal chemicals and drugs in this country might be enormously increased, becoming a thriving industry and producing its products at prices which will compete in the world's markets. Britain has the necessary raw materials within the Empire, and more than sufficient ability among her manufacturers to work up the raw materials into the finest possible finished products.

§ 2.

Taking first the raw materials from which natural alkaloids are obtained, full particulars, as far as statistics are concerned, are available for opium and bark cinchona, great quantities of both of which are imported into the United Kingdom annually.

Turkey and Persia are our main sources of supply of opium, as, indeed, they are for the world. The imports of opium in 1921 and 1922 were only a fraction of those in 1913, but in both periods Turkey predominated as our supplier. In 1913 Britain imported from European Turkey 155,377 pounds of opium and from Asiatic Turkey 217,216 pounds; also 136,464 pounds from Persia. The imports in 1921 were: European Turkey, 22,303 pounds, and Smyrna, 25,445 pounds, the latter presumably including Persian and Asiatic Turkish supplies, since neither of these countries shows any export. An import of 38,000 pounds from Hong Kong is also shown in 1913, but this would probably be of Chinese

origin, while India must also be mentioned in this connection. Indian opium does not contain a high enough percentage of morphia to comply with the requirements of the British Pharmacopœia for opium, but in normal times some quantity of opium is imported from India for use in the manufacture of morphine in this country.

External Trade of the United Kingdom in Opium and Bark Cinchona.

Product.	Source or Destination.	Imports. 1913 (*Lbs.*).	Imports. 1921 (*Lbs.*).	Exports. 1913 (*Lbs.*).	Exports. 1921 (*Lbs.*).	Re-Exports. 1913 (*Lbs.*).	Re-Exports. 1921 (*Lbs.*).
Opium ..	Empire	44,978	Nil	308	494	112,526	3,280
	Foreign countries	521,856	62,574	11,797	9,976	168,988	2,846
	Total ..	566,834	62,574	12,105	10,470	281,514	6,126
		(*Cwts.*).	(*Cwts.*).	(*Cwts.*).	(*Cwts.*).	(*Cwts.*).	(*Cwts.*).
Bark cinchona	Empire	4,844	4,394	No statistics	6	13,798	94
	Foreign countries	21,278	14,433		15	4,823	3,766
	Total ..	26,122	18,827	—	21	18,621	3,860

For obvious reasons our export trade in opium " Produce and Manufactures of the United Kingdom " is inconsiderable, while for equally obvious reasons our re-exports are quite large. In 1913 Great Britain exported 168,988 pounds of opium of foreign origin to foreign countries, the most important of these exports being as follows: Holland, 61,809 pounds; Japan, 23,879 pounds; United States, 25,795 pounds. In addition to these quantities 46,426 pounds were sent to the Straits Settlements and 58,580 pounds to Hong Kong.

Opium is the raw product from which morphine is obtained industrially. It also contains low percentages of many other vegetable alkaloids, such as narcotine and codeine.

The greater bulk of our supplies of cinchona bark is imported from Java, whence we received 10,435 hundredweights in 1913, and 12,363 hundredweights in 1921. We also import a considerable amount from India, our purchases from that country amounting to 4,642 hundredweights in 1913, and 3,747 hundredweights in 1921. Just as in the case of opium, our re-export trade in cinchona bark is considerable. In 1913, 4,823 hundredweights were re-exported to foreign countries, and 13,798 hundredweights to India. It should be added, however, that from 1919 to 1922 practically no business was done in cinchona bark with either India or other British Possessions, and, in fact, our total export was only 3,860 hundredweights. France is the most consistent buyer.

Cinchona bark, or Peruvian bark, is the source from which quinine is obtained, besides also containing other vegetable alkaloids such as cinchonine.

§ 3.

We will now consider the most important vegetable alkaloids of which statistical details are available—namely, morphine, cocaine, and quinine. The two first named have in recent years attained unpleasant notoriety through their frequent abuse and the growing illegal traffic in them. They are, nevertheless, worthy of the highest regard through their enormous medicinal value.

Below we give the trade statistics of these three alkaloids:

External Trade of the United Kingdom in Certain Alkaloids (Ounces).

Product.	Source or Destination.	*Imports.* 1913.	*Imports.* 1921.	*Exports.* 1913.	*Exports.* 1921.	*Re-Exports.* 1913.	*Re-Exports.* 1921.
Cocaine and its salts	Empire	4,370	—	3,054	2,122	2,496	811
	Foreign countries	50,976	6,608	300	4,271	21,152	416
	Total ..	55,346	6,608	3,354	6,393	23,648	1,227
Morphine and its salts	Empire	Nil	847	7,216	10,159	1,932	Nil
	Foreign countries	52	62	398,938	70,786	4,000	Nil
	Total ..	52	909	406,154	80,945	5,932	Nil
Quinine and its salts	Empire	Nil	21,168	1,046,116	733,691	243,403	102,666
	Foreign countries	2,422,944	936,376	328,212	280,219	62,188	579,810
	Total ..	2,422,944	957,544	1,374,328	1,013,910	305,591	682,476

Cocaine is not made to any very great extent in this country, and the relatively high imports are to be expected. In 1913 almost half of our import was of German origin, the actual quantity being 23,858 ounces; of the remainder, 19,277 ounces were of Peruvian origin. In that year 4,370 ounces was imported from British Possessions, but no details of origin were given. In 1921 the importation of cocaine had fallen to 6,608 ounces. It will be seen from the above table that our exports of cocaine were very much less than our imports in 1913, the balance being adjusted in 1921. The bulk of our export trade in this drug has been in the foreign manufactured product; 20,152 ounces were exported to Germany in 1913, a quantity which is only very little less than what we imported from her.

Our trading in morphine and morphia salts is chiefly a genuine export business in the home produced drug, and we shall, therefore, merely give the most important destinations. Our best and most consistent buyer is France, who imported from us the following amounts of morphine: 1913, 24,052 ounces; 1921, 48,811 ounces.

It should be added that in 1919 France imported 140,873 ounces, in 1920, 152,754 ounces, and in 1922, 102,980 ounces. Although very large quantities of morphine have been bought by other countries from time to time, this buying has been spasmodic. In 1913, for instance, Japan bought 252,110 ounces from

Britain, and Germany 81,944 ounces, but neither of these countries has made any considerable purchases from us since that year. Again, in 1919, 121,474 ounces was exported to the United States of America, but there is no record of her buying anything approaching that quantity before or since. A steady business is also carried on with Canada and Australia.

The United Kingdom does an enormous volume of business in quinine salts. In the year 1913 she imported from Holland alone 1,009,970 ounces, her lowest imports from that country being 65,887 ounces in 1921; and from Java 390,400 ounces in 1913, and 666,304 ounces in 1921. In the years 1919 and 1920 our imports from Holland and Java reached the enormous totals of 5,732,745 and 4,307,307 ounces. British imports of quinine from Imperial sources are entirely dwarfed by those from other countries, even the highest total recorded in recent years—namely, 89,968 ounces in 1920. Germany is also an important supplier of this drug, as is also America.

§ 4.

We have reviewed above the three most important vegetable alkaloids, and, therefore, we turn now to synthetic compounds, dealing also with menthol, which is a natural compound. The most important synthetic drugs are aspirin, phenacetin, and glycerophosphates, but trade statistics are not available for the year 1913 in respect of any of them.

External Trade of the United Kingdom in Certain Drugs (Lbs.).

Product.	*Source or Destination.*	*Imports.* 1921.	*Exports.* 1921.	*Re-Exports.* 1921.
Menthol	Empire	1,500	251	1,025
	Foreign countries	28,680	1,150	46,981
	Total	30,180	1,401	48,006
Aspirin	Empire	460	32,467	2,988
	Foreign countries	287,370	6,154	588
	Total	287,830	38,621	3,576
Phenacetin	Empire	Nil	2,961	2,432
	Foreign countries	54,807	432	2,089
	Total	54,807	3,393	4,521
Glycerophosphates	Empire	135	1,549	27
	Foreign countries	9,718	428	10,311
	Total	9,853	1,977	10,338

British imports of menthol are mainly from Japan, and in 1920, out of a total of 195,288 pounds, as much as 175,138 pounds was imported from that country.

In 1921, 27,038 pounds was of Japanese origin, and in 1922, 53,658 pounds. Imports of menthol from Empire sources amounted in 1921 only to 1,500 pounds in all, and the countries of origin were not specified. No exports of menthol of British manufacture worthy of note were made in 1921, but a considerable business in the re-exported product was done. Germany and the United States were both important buyers, the amounts being 16,535 and 15,592 pounds respectively. France purchased 5,862 pounds in 1921. Over the three years 1920 to 1922 the United States made the greatest purchases.

Aspirin, or acetyl salicylic acid, is the most important of the four drugs in this section. Germany and France both export great quantities to this market, and in 1921 British imports of aspirin were more than double those of either 1920 or 1922. In that year 121,587 pounds was received from France alone, while Germany supplied 75,375 pounds and the United States 67,020 pounds. Such imports as were made from other parts of the Empire were of Canadian origin only, but the amount was inconsiderable.

In 1920 Britain exported considerable quantities of home produced aspirin, but in 1921 the figure had fallen from 207,218 to 38,621 pounds, very considerably less than was imported. Most of our exports were to British Dominions, Australia being by far the largest customer, and Canada second, with about half the quantity purchased by Australia. India and South Africa are also quite important markets. Re-exports of aspirin are relatively inconsiderable.

With regard to phenacetin, the United Kingdom is a heavy importer of the foreign article. Our purchases were mainly from America in 1920, and from Germany and Switzerland in 1921. Exports of both British and foreign phenacetin are very small and are not worthy of comment.

Turning now to glycerophosphates, all these products are entered under that heading without the metallic radicle being mentioned. Our trade in them, whether import or export, is not very great, the larger proportion of our purchases from abroad being of German, French, or American origin. In 1921 Britain exported 10,080 pounds of foreign glycerophosphates to America, but otherwise export trade in these compounds is negligible.

Chloroform and chloral hydrate will conclude our chapter on drugs and medicinal chemicals.

External Trade of the United Kingdom in Chloroform and Chloral Hydrate (Lbs.).

Product.	*Source or Destination.*	*Imports.*		*Exports.*		*Re-Exports.*	
		1913.	1921.	1913.	1921.	1913.	1921.
Chloroform ..	Empire	Nil	1	No	74,163	380	Nil
	Foreign countries	1,366	1,287	statistics	13,875	214	Nil
	Total ..	1,366	1,288	—	88,038	594	Nil
Chloral hydrate ..	Empire	Nil	Nil	No	534	2,187	1,129
	Foreign countries	23,501	25,628	statistics	330	1,083	1,697
	Total ..	23,501	25,628	—	864	3,270	2,826

Chloral, from which chloral hydrate is obtained by combination with water, is manufactured by the chlorination of ethyl alcohol. Chloroform is also obtained from ethyl alcohol by distillation of a mixture of this compound with bleaching powder. It will be observed from the above table that Britain is an exporter of chloroform in considerable quantity, and in fact its manufacture has long been carried out in this country. Of our exports the major portion goes to the Dominions, Australia, Canada, and India being the greatest markets; the actual quantities shipped to those three countries in 1921 were 29,099, 10,718, and 15,817 pounds respectively.

On the other hand, Britain is mainly an importer of chloral hydrate. In 1913 the bulk of our supplies was of German origin, but in 1921 the United States had replaced Germany as a supplier. German exports of chloral hydrate to this country fell from 19,994 pounds in 1913 to 4,045 pounds in 1921, while America increased her exports to us from 288 pounds in 1913 to 14,249 pounds in 1921.

There is no interesting feature in the imports and re-exports of chloroform, nor in the exports and re-exports of chloral hydrate

With regard to the distribution of medicinal chemicals, the sale and price of the quinine group of alkaloids is controlled by the Dutch manufacturers, who also command to a great extent the supplies of raw material. The manufacture of medicinal chemicals is mainly carried out by manufacturing chemists who, in a great number of cases, supply their own retail establishments, thus distributing their products direct to the consumers. Very little of this business is in the hands of merchants, and the pharmacists almost invariably deal directly with the manufacturer.

CHAPTER IX

GIBRALTAR. MALTA. CYPRUS

GIBRALTAR

GIBRALTAR is a free port, and no statistics of either imports or exports are kept. It does not, however, seem probable that any consumption of chemicals and allied products goes on, apart from the domestic and pharmaceutical needs of the garrison and civil population, but the peninsula deserves a brief notice here in its capacity as a forwarding station for the trade between the United Kingdom and Northern Africa.

MALTA

Malta is essentially a producer of vegetables, fruit, etc., in so far as any local industry is concerned, but so far as can be judged from the statistics the use of fertilizers is not considered necessary.

The headings shown in the Blue Book are rather vague, but in the pre-war year the import of acids and alkalies amounted to £3,843, the corresponding total for 1921 being £4,488. The United Kingdom was the chief source of supply

for both years, and the same applies to chemicals and apothecaries' wares, which are entered at £12,344 in 1913-14 and £14,020 in 1921.

Sulphur powder to a value of £995 was brought in from Italy in the later year, and the import of manures was insignificant in both periods.

The export trade is negligible, and the only heading worthy of mention is tar, of which 1,147 hundredweights were sent to Egypt, etc., in 1921, the whole quantity being entered as local produce.

CYPRUS

Cyprus has some resources of copper and gypsum in addition to the deposit of pyrites mentioned in the introduction to this volume, but the local activity is mainly of an agricultural and pastoral order, exports of possible interest from the point of view of this volume being cotton, silk, wool, and various crops.

" Manure, Fertilizers," is the largest import heading, the quantity for 1913 being 17,266 hundredweights (£5,617), from Greece, Belgium, and Holland, while in 1921, 21,211 hundredweights were imported, the value being noted at £14,387, and the chief suppliers Greece and Holland.

The only export in the chemical group is salt, 300 tons going to Turkey in the pre-war year against a total of 885 tons after the War; the chief customers for the later year were Turkey and Syria, and the material was entirely of local origin.

SECTION II.—ASIA

CHAPTER X

INDIA AND BURMA

§ 1.

THE statistics for these two countries are published under India, and it will therefore be convenient to treat them together. When Burma is of special importance in any connection, a note will be made to this effect.

India is a fairly important market from the point of view of the chemical manufacturer, but it may safely be stated that its manufacturing—and, therefore, chemical-consuming—industry is as yet comparatively unimportant from an Empire point of view. The total value of all private imports of merchandise in the fiscal year 1913-14 is given as £122,165,288, and of this figure more than half consisted of manufactured articles into the production of which chemicals enter in greater or less degree, while the total of articles wholly or mainly manufactured was £96,769,443.

Taking now the export figures for the same year, we find that out of a total of

£162,800,999 of Indian merchandise, the "mainly manufactured" section only contributed £36,394,101, and of this we surmise from the details shown that only about £15 to £20,000,000 would be classed as chemical consuming manufactures.

The above details have purposely been given for pre-war years, since we believe that they are more comprehensible on this basis, and it must, of course, be admitted that the War helped to expand India's home industry as it did in the case of every other country. It is unfortunate that this expansion was not able to survive the slump which followed the post-war boom. The result, however, is satisfactory to this extent, that chemical enterprise started on sound foundations in India has survived the shock. These enterprises, of which details will be given later, are likely to develop, although progress must be slow in view of the scarcity of well-trained and well-educated labour.

It may be added that the Government is not unmindful of its part in the commercial development of the country. As factors for the good of industry as a whole, we would instance the Commercial Intelligence Department at Calcutta, with which are incorporated the Statistical Department and the Commercial Library; the Geological Survey Department and the Research Institutes in the various Provinces. The chemical research work carried out under the Department of Industries of the Government of India, and the Indian Science Congress held triennially under the auspices of the said Department, are specially deserving of mention. Out of a considerable list of researches in progress in 1920, the following are, perhaps, specially worthy of note: the electrolytic preparation of magnesium. The destructive distillation of various woods, etc. The manufacture of certain sodium compounds from native sodium sulphate. Indigenous sources of tartaric acid. The manufacture of sodium carbonate from Mysore alkaline earths. The manufacture of caffeine.

§ 2.

Turning now to a brief account of the natural resources of India and Burma for the manufacture of chemicals, it may be stated that the chief mineral raw materials noted are ores of manganese, lead, tungsten, zinc, copper, monazite sand, magnesite, chromite, and potassium nitrate.

The first of these is chiefly produced in the Madras Presidency, where also is situated the chief Indian source of magnesite. Chromite is found in Mysore, Baluchistan, Bihar and Orissa, and other parts, while copper is noted especially in Sikkim and Bihar and Orissa, the commercial production being from the latter area. The remaining metals, lead, tungsten, and zinc, are especially Burmese, and Travancore is the chief centre for monazite sand.

India is also a producer of salt, lime, and potashes, while natural sodium sulphate is found, as has been indicated above. Coal is found very generally and the output has increased from year to year, while water power is available in the country, though we cannot trace any considerable attempts at its use for the manufacture of chemicals. Finally, India is, of course, an important source of supply for opium, nux vomica, tea refuse for caffeine manufacture, etc., and in the past has been noted for natural indigo.

§ 3.

The only production figures we have been able to obtain for chemicals in India relate to nitrate of potash—saltpetre—and sulphate of ammonia. The production of refined saltpetre is given for 1913-14 as 33,014,519 pounds, and for 1917-18—the last year for which production figures are available—as 48,186,567 pounds, while it is stated that 453 refineries were in existence in 1917-18 against 327 in the pre-war year. The sulphate of ammonia production was estimated in 1919 at 3,000 tons, chiefly for export.

Turning now to other chemicals, we do not observe any local manufacture of outstanding importance. What may be taken as a fairly complete list of local manufacturers and products is, however, issued under the title of "Chemicals Manufactured in India" (Bulletins of Indian Industries and Labour, No. 21), and we note in this a number of works producing hydrochloric, sulphuric, and nitric acids, alum, various ammonia products, green copperas, iron, lead, magnesium and potassium compounds, together with a few tar distillers and local sources of supply for a number of other chemicals. We do not, however, see any means of determining to what extent these works would be regarded as actual producers of any given chemical from the point of view of the English manufacturer, nor is it possible to arrive at any details as to their respective outputs. The sulphuric acid industry exists in India, but not on a scale proportionate to local requirements. It is unfortunate that sulphur does not occur in India in a form suitable for easy extraction and conversion. Natural sulphates do, however, occur in sufficient quantities, and it is possible they may be worked up on an increasing scale in future.

We will now pass on to consideration of the external trade of India in chemicals, taking the heavy chemicals first. It must be pointed out that the statistics noted are for the fiscal year ending March 31, and, as in the case of Canada, we have taken the periods which are substantially the years named by us. Separate statistics are also given for Government stores, and where these are entered by name we have included them in our total figures. In a number of cases, however, especially in the heavy chemical class, value only is given and products "lumped," and the total weights we set down may be to that extent inaccurate.

§ 4.

HEAVY CHEMICALS.

India is not to any large extent an exporter in this class. The articles worthy of note are casein, nitrate of potash, and borax, and the details of these are given on p. 111.

Strictly speaking, borax is not a production of British India, as it is imported from Tibet and Kashmir; it is, however, refined in India and is usually considered Indian in origin. Other exports are alum, arsenic, other potassium and sodium compounds, but the trade is not worth detailing here.

Turning now to India's chemical purchases, we find the chief of these to be sulphuric acid, alum, and sulphate of alumina, bleaching materials, magnesium chloride and sulphate, sodium carbonate, caustic and bicarbonate, calcium carbide, sulphur, ammonia and salts thereof, camphor, potassium compounds and salt.

Exports of Indian Produced Casein, Nitrate of Potash, and Borax (Cwts.).

Product.	*Destination.*	1913.	1921.
Casein	Empire	No statistics	4,780
	Foreign countries		134
	Total	—	4,914
Nitrate of potash	Empire	229,984	224,158
	Foreign countries	38,086	10,791
	Total	268,070	234,949
Borax	Empire	4,203	5,436
	Foreign countries	67	27
	Total	4,270	5,463

Space does not permit us to give full details of all the articles we have mentioned as purchases, but the following table shows the chief particulars of the most important chemicals or groups:

Imports of Sodium Carbonate, Bicarbonate and Caustic, Sulphuric Acid, Alum, etc., and Bleaching Materials into India (Cwts.).

Product.	*Source.*	1913.	1921.
Sodium carbonate, soda ash, and soda crystals	Empire	422,749	579,137
	Foreign countries	391	1,152
	Total	423,140	580,289
Sodium bicarbonate	Empire	86,368	108,309
	Foreign countries	45	36
	Total	86,413	108,345
Sodium caustic	Empire	91,018	66,644
	Foreign countries	7,179	492
	Total	98,197	67,136
Sulphuric acid	Empire	63,719	4,544
	Foreign countries	219	17
	Total	63,938	4,561
Alum and aluminous sulphates ..	Empire	77,019	90,334
	Foreign countries	13,060	16,702
	Total	90,079	107,036
Bleaching materials	Empire	58,062	78,084
	Foreign countries	17,566	6,172
	Total	75,628	84,256

As regards most of the other products we have named, it will be enough if we give a few general details concerning their import.

In the case of calcium carbide, Germany supplied the largest quota in 1913, but the greater part of this trade was in Norway's hands in 1921, the total figures for these two years being 19,998 and 11,692 hundredweights respectively.

Sulphur to a total of 126,541 hundredweights was brought in during 1913, the bulk of this coming from extra-Empire sources, and Burma taking a good proportion of the total, while the same state of affairs was in force in 1921, the quantity imported being 125,535 hundredweights. Turning to ammonia products, we find that the bulk of this entry is from the United Kingdom both before and after the War, anhydrous ammonia accounting for 2,206 hundredweights out of the 1921 total of 10,318 hundredweights, the balance being unspecified ammonia salts.

The final group we have named is potassium compounds, and detailed figures are not available for 1913; in the later year, however, the headings given cover bichromate (3,566 hundredweights), chlorate (3,226 hundredweights), cyanide, nitrate, and other sorts, the total import being 8,590 hundredweights, of which the Empire's share is 1,301 hundredweights. The total figure in 1913 was 14,560 hundredweights.

We may conclude our heavy chemical section with the particulars relating to camphor and salt, and as the import of these two articles is of fair value, we think it well to give the full details, although, apart from the question of value, these two products are not, of course, in any way allied.

IMPORTS OF CAMPHOR AND SALT INTO INDIA.

Product.	*Source.*	1913 (*Lbs.*).	1921 (*Lbs.*).
Camphor	Empire	255,990	193,774
	Foreign countries	1,107,247	494,190
	Total	1,363,237	687,964
		(*Tons*).	(*Tons*).
Salt	Empire	252,823	331,108
	Foreign countries	354,117	141,319
	Total	606,940	472,427

§ 5.

COAL TAR PRODUCTS, INTERMEDIATES, AND DYESTUFFS.

The information available regarding the articles in these two groups is not very full, and we have therefore thought it well to deal with them as one section.

We can find no mention of India as an exporter of any of these products, but the import statistics refer to disinfectants and coal tar and pitch, while India is, of course, an important buyer of dyestuffs.

Taking the coal tar section first, the total quantity of disinfectants imported in 1913 was 25,395 hundredweights, and in 1921, 11,033 hundredweights, the United Kingdom being far and away ahead of all competitors in both years.

No amount is noted for coal tar and pitch in 1913, while in 1921 the quantity is relatively unimportant at 88,301 hundredweights, out of which the United Kingdom again supplied the bulk.

Dealing now with dyestuffs, we consider India of such importance in this connection that we propose to give as much detail as is possible.

IMPORTS OF COAL TAR DYESTUFFS AND SYNTHETIC INDIGO INTO INDIA.

Product.	*Source.*	1913 (*Lbs.*).	1921 (*Lbs.*).
Alizarine dyes	Empire	963,752	1,865,165
	Foreign countries	5,505,987	3,857,913
	Total	6,469,739	5,723,078
Aniline dyes	Empire	102,869	1,104,579
	Foreign countries	9,600,253	4,765,470
	Total	9,703,122	5,870,049
Other coal tar dyes	Empire	1,232	4,002
	Foreign countries	71,802	17,404
	Total	73,034	21,406
		(*Cwts.*).	(*Cwts.*).
Synthetic indigo	Empire	29	7
	Foreign countries	6,022	1,035
	Total	6,051	1,042

§ 6.

FERTILIZERS.

Quantities of such manures as blood meal, horn meal, sulphate of ammonia, etc., are produced and exported, but this trade is scarcely large enough to warrant detailed consideration; India, however, is one of the great sources of supply for bones and bone manures, and we give on p. 114 the exports of these products, together with the figures relating to fish guano and manure, which articles, though quite secondary to bones, still account for a good part of India's fertilizer exports.

Turning now to the import statistics, we find the total quantities of fertilizers, as is to be expected, of little importance. It will be enough to say that the grand total in 1913 amounted to 9,205 tons, and in 1921 to 959 tons, the quantities under any identifiable heading being negligible.

EXPORTS OF INDIAN PRODUCED BONE AND FISH MANURE (TONS).

Product.	*Destination.*	1913.	1921.
Bones, crushed and uncrushed	Empire	23,224	3,031
	Foreign countries	82,189	36,098
	Total	105,413	39,129
Bone meal	Empire	—	23,160
	Foreign countries	—	26,716
	Total	—	49,876
Total bone manures, all sorts		105,413	89,005
Fish guano and manure	Empire	15,723	9,337
	Foreign countries	561	120
	Total	16,284	9,457

Including bone meal in 1913.

§ 7.

FINE CHEMICALS, DRUGS AND MEDICINAL CHEMICALS.

Here, again, we feel justified in treating two groups together, and, as a matter of fact, the only materials worthy of mention come in the latter class.

India is an important producer of opium, and other articles for which export statistics are available are senna and nux vomica. The table is as follows:

EXPORTS OF INDIAN PRODUCED OPIUM, SENNA, AND NUX VOMICA (CWTS.).

Product.	*Destination.*	1913.	1921.
Opium	Empire	7,630	7,089
	Foreign countries	9,228	8,108
	Total	16,858	15,197
Senna	Empire	11,528	13,815
	Foreign countries	14,922	27,902
	Total	26,450	41,717
Nux vomica	Empire	18,992	22,665
	Foreign countries	27,157	24,524
	Total	46,149	47,189

Other exports under this heading are cinchona bark, aloes, asafœtida, and galangal, but the quantities sent out are relatively unimportant.

The chief of India's purchases in this group are cassia lignea and quinine salts. In the case of the former, the total quantity imported in 1913 was 46,470 hundredweights, of which the Empire furnished rather less than half, while in 1921 the amount was practically the same at 45,731 hundredweights, but the Empire's share fell to rather more than one-third.

In quinine salts, separate statistics are shown in 1921 for quinine sulphate or bisulphate, quinine hydrochloride or dihydrochloride, quinine salts, other sorts, and cinchona bark. In 1913, however, all these products were grouped under one heading, and we think that our purpose will be served by giving the statistics in this manner.

IMPORTS OF QUININE AND ALKALOIDS THEREOF (INCLUDING CINCHONA BARK) INTO INDIA (LBS.).

Source.	1913.	1921.
Empire	82,282	37,944
Foreign countries	38,507	1,331,430
Total	120,789	1,369,374

Other articles in the drug group of which import statistics are given are aloes, asafœtida, cocaine, etc., but the quantities entered are not sufficient to warrant our further consideration.

§ 8.

Having concluded our survey of the external trade in chemicals, we may now consider the principal areas of production, and it will be convenient to include in this section some notes on the chief consuming trades.

It is clear from the directory mentioned above that the chief production centres for general chemicals and drugs are Calcutta and Bombay, though Cawnpore also has its chemical factories. For coal tar and sulphate of ammonia the chief centre seems to be the Province of Bihar and Orissa, but other distillation products, such as creosote, naphthalene, and pitch, are produced in Bengal, while the potassium nitrate industry is centred in the Punjab.

Only two chemical works are noted in Burma, one in Rangoon and one at Thingangyun, but apparently these two between them turn out a considerable number of products.

Turning now to the question of consuming trades, it will be obvious that a proportion of the chemical imports is worked up in the chemical factories themselves. Other outlets of interest in this connection are cotton mills, tanneries, jute mills, leather goods, woollen mills, paint works, glass works, etc., while dyes are used for piece goods, carpets, and other purposes.

§ 9.

Several large British firms have branches or representatives in India, but the export and import trade in chemicals is carried out as well through the intermediary of merchant houses, many of which have their head offices in London, where much of their import buying is done. Goods are brought in in quantity

and sent into godown, where they are broken up and despatched to the consumer, usually passing through other hands on the way. Broadly speaking, also, the articles exported are collected in the crude by many hands, and pass through various channels before the product in bulk for shipment reaches the exporter; and it appears probable that it will be some time yet before India is sufficiently developed from an industrial point of view to avoid this complicated process of barter and collection and ship straight from source to customer.

§ 10.

India does a certain amount of re-export trade in chemicals, but the total value in 1913 was less than £10,000, and only meagre details are given. This section does not seem to merit further consideration, beyond saying that here the chief countries of destination are Ceylon, Mauritius and Dependencies, Persia and the Persian Gulf, Arabia, the Straits Settlements and Bahrein Islands, etc.

§ 11.

In concluding this review of the chemical industry of India, we wish to acknowledge that we have gained much valuable assistance and knowledge from the *Handbook of Commercial Information for India*, written by C. W. E. Cotton, Esq., I.C.S., and published by the Government of India. From this book, also, are abstracted the production figures noted above.

CHAPTER XI

CEYLON

THE chief part of the commercial revenue of Ceylon is derived from the products of plantations, the most important of which are tea, products of the coconut palm, rubber, etc., while plumbago is also exported. The only local production we have been able to trace, in so far as this book is concerned, is salt, which is a Government monopoly, monazite sand, and cinchona bark and nux vomica, of which details will be given later.

As is to be expected, fertilizers figure largely in the import returns, and the quantity brought in makes it advisable to give the main particulars in tabular form. In order to save space the source we shall show will be the chief supplier in each case, and it should also be borne in mind that the statistical classifications were altered during the year 1921, which may possibly give rise to some slight inaccuracy. We do not, however, consider that this is likely to be the case.

It will be observed from this table that the quantity of fertilizers imported had fallen considerably during the period under review, but it can scarcely be assumed that the real demand has lessened. It seems more probable that the effect of stocks purchased during the boom was still being felt in 1921.

Imports of Certain Fertilizers into Ceylon (Cwts.).

Product.	1913.		1921.	
	Quantity.	*Source.*	*Quantity.*	*Source.*
Sulphate of ammonia ..	48,547	United Kingdom	3,276	United Kingdom
Kainite	32,500	Germany	1,136	British India
Guano	73,223	British India	31,518	British India
Basic slag	127,326	Germany	880	United Kingdom
Blood meal	52,224	United Kingdom	3,608	British India
Bone manure†	132,891	British India	101,036	British India
Fish manure	414,527	United Kingdom	72,353	British India
Muriate of potash	24,109	Germany	10,060	France
Sulphate of potash	101,650	Germany	1,017	Germany

The heading is "Guano" in 1913 and January-June, 1921; for July-December, 1921, it is "Guano: Fish Guano," but it appears to be the same product.

† "Bone Manure" and "Bone Meal" are the headings, but it seems safe to assume that the product is the same.

We have given above the details of the chief fertilizer imports, but certain other articles are noted and may be dismissed with a few particulars in general terms. Rather more than 2,000 tons of saltpetre refuse were brought in from British India in 1913; the quantity for the latter half of 1921 being about 640 tons from the same source.

More than 2,500 tons of superphosphate was purchased, chiefly from Germany and Belgium, in the earlier year, but the only entry traceable for the post-war period is 150 tons, all from Belgium, while a small quantity of nitrate of soda was brought in for 1913, with no corresponding figure for 1921.

Turning now to the imports of other chemicals, these are not of particular interest. The chief items are camphor, of which 403 and 220 hundredweights are the quantities for the two years, Japan being the chief supplier; bleaching materials, 2,039 and 1,494 hundredweights, Germany as the chief supplier in 1913 giving place to the United Kingdom in 1921; and soda, the import for the pre-war year being 6,257 hundredweights, and for the later year 16,327 hundredweights. The United Kingdom has done the bulk of this trade in both years.

The acid group is the only remaining section to be dealt with, though certain quantities of tar, pitch, sulphur, dyes, and other products are mentioned. Sulphuric acid totalling 12,744 gallons was brought in before the War, together with other acids, 33,369 gallons; the corresponding figures for the first half of 1921 are 7,323 and 284 gallons respectively, but in July, 1921, the classifications become more informative and show sulphuric acid 6,998 gallons, acetic acid 4,059 gallons, other acids 703 gallons.

It is, therefore, reasonable to suppose that acetic acid formed a fair proportion of the 1913 import of other acids.

We have given the foregoing statistics in gallons, as that is how they are shown in the Blue Book; we think, however, they will be rendered more comprehensible

by working them to weights where this is possible, and the figures so worked out are:

	1913 (*Cwts.*).	1921 (*Cwts.*).
Sulphuric acid	2,055	2,309
Acetic acid (July to December)	.. ..	328

Turning now to the other departments of Ceylon's external trade, we find a small amount of re-export being carried out in a few articles, but this trade is not of sufficient interest to be worth detailing.

The exports of local produce consist mainly of an insignificant item of manufactured drugs, together with cinchona bark and nux vomica. The statistics are quite clear for 1913, the quantities of the two articles being 32,821 and 8,176 pounds respectively; for the first half of 1921 they are 97,349 and 61,824 pounds, but the classifications were altered for the latter half of that year and we do not see any means of arriving at accurate figures, although it may safely be taken from the details already given that the trade in both these articles was better than in 1913.

The chief buyer of the cinchona bark was France in the earlier year and the United States in the later, while the nux vomica is primarily of interest to the United Kingdom.

CHAPTER XII

BRITISH MALAYA

STATISTICS are available for the Straits Settlements for 1913 and 1921, and for the Federated Malay States for these two years, while a volume has been produced since the War which covers the whole of British Malaya.

We are of the opinion that the fairest view of the position is obtained by treating British Malaya as a whole, and disregarding trade between the various parts thereof, which would have to be considered in dealing with the sections as separate entities. Our statistics will, therefore, relate primarily to 1921, but where we consider it advisable a reference will be made to 1913, though any statistics so quoted may not be perfectly comparable.

British Malaya includes Singapore and Penang, Labuan, Christmas Island, and the Dindings, together with the Federated Malay States and the Unfederated States of Johore, Perlis, Keda, Kelantan, and Trengganu. From the point of view of this volume the chief centre of interest is Christmas Island, as will be seen later.

The chief activities of British Malaya consist of mining and agriculture, though the ports of Penang and Singapore act as collecting and distributing centres for areas outside British Malaya as well as for their own connections.

The agricultural products which are chiefly exported consist of rubber, copra, coconut oil, etc., and recently rubber latex for paper-making, while the mining exports of tin and tungsten may be said, along with coal and phosphate of lime, to sum up the chief resources of the country, in so far as this book is con-

cerned, though arsenical and sulphurous ores are found as impurities in the tin ores, a certain amount of low-grade iron ore is reported, and discoveries of lead have been made in Trengganu.

Turning now to the imports of British Malaya, we do not find many headings noted separately, a large number of articles doubtless being included in the "lumped" classification "Chemicals," which totalled, in 1921, 1,361,732 dollars, or £158,869. (The Malayan dollar has a fixed exchange of 2s. 4d.) The United Kingdom was the chief supplier.

The largest individual heading in terms of value is opium, of which 2,933 chests were imported, chiefly from British India and Burma, while salt to a total of (in round figures) 49,200 tons is also deserving of mention, the chief source for this being Siam. A fairly accurate comparative figure for 1913 is 70,400 tons.

Passing on from salt, the only other alkali heading is soda, of which about 60 tons were brought in from the United Kingdom. A small quantity of sulphur is also noted, but saltpetre, at about 330 tons from British India and Burma, is more considerable.

As might be expected in a rubber country, acetic acid is of some importance, the quantity being 48,660 gallons, or approximately 137 tons, and this trade is largely in the hands of Canada, while camphor to a total of 1,440 hundredweights was brought in. This material is largely the produce of Sumatra, and Singapore acts as a collecting station and ships it on to British India, etc.

We may close this account of the import trade with a reference to manures, coal tar products, and dyestuffs. The named imports of the former are inconsiderable, but manures other than guano and bones are a value of roughly £40,000, the chief sources of supply being British India and Burma, and Sumatra.

Coal tar and pitch, approximating to 2,860 tons, were imported largely from the United Kingdom, while aniline dyes to a value of about £10,700 are noted, and over 620 hundredweights of synthetic indigo, the former from Germany and the latter from the Netherlands. The trade in synthetic indigo is considerably less than pre-war, a minimum figure for 1913 being 3,950 hundredweights.

We may now pass on to consideration of the export section of the trade, and, as we indicated above, the chief article of interest is derived from Christmas Island, practically all of the inhabitants of which are the employees of the Christmas Island Phosphate Company, which was formed to work the large deposits of phosphate of lime which are found in the island.

The exports of this product in 1913 reached a total of 150,005 tons, and the buyers were all over the world, the chief ones being Germany and Austria. In 1921 the trade had fallen off to 86,505 tons, and the largest buyers were Japan and Australia.

Apart from this phosphate, any export trade noted is largely of an entrepôt character, goods being re-shipped to Siam, Sumatra, the Dutch East Indies, etc.,

The nearest pre-war figure we can give for purposes of comparison is an approximate one of 61,110 gallons, but this is probably too low.

and the character of the products moving may be fairly gathered from our survey of the import trade. The chief articles in point of value are salt and opium, while we have already instanced camphor, which might, perhaps, almost be considered a local product. A fair quantity of acetic acid also is shipped to British North Borneo.

CHAPTER XIII

HONG KONG. ADEN AND SOCOTRA

HONG KONG

It may be safely stated that Hong Kong will never be of importance as a producer of chemicals—at any rate, in so far as our present knowledge of the colony is concerned. Its geographical situation and magnificent harbour, however, have made it into a distributing station of considerable importance to the Empire, and a large entrepôt trade in chemicals is carried on with South China, French Indo-China, North China, etc.

We can find no chemical statistics relating to the year 1913, apart from an import of 479 tons of opium, but fairly full and very clear statistics are available for 1921, and possibly the most satisfactory way of dealing with these will be by the chief countries of origin. It will be unnecessary to give any figures relating to exports, since it is quite clear that the quantities of goods retained for local consumption are relatively insignificant.

It must be stated that Japan figures fairly largely as a supplier, the chief articles noted being shown in the following table:

Japanese Imports into Hong Kong in 1921, and Chief Export Destinations (Tons).

Product.	*Quantity.*	*Destination.*	*Product.*	*Quantity.*	*Destination.*
Hydrochloric acid	245	French Indo-China	Bleaching powder	856	South China
Nitric acid ..	87	South China	Calcium carbide	384	French Indo-China
Sulphuric acid	557	South China	Camphor ..	31	India
Sulphur ..	1,508	South China	Phosphorus ..	34½	South China

Taking next supplies chiefly from the United Kingdom, it is regrettable to find that these form a far smaller total than those from Japan. The most important are:

United Kingdom Imports into Hong Kong in 1921, and Chief Export Destinations.

Product.	*Quantity (Tons).*	*Destination.*	*Product.*	*Quantity (Tons).*	*Destination.*
Glycerine	119	South China	Soda ash ..	1,488	South China
Manure, all sorts ..	3,613	South China	Caustic soda ..	568	South China
	(£).			(£).	
Other chemicals and drugs	133,974	Various	Disinfectants ..	17,590	South China

As will be realized from the foregoing tables, Japan and the United Kingdom between them are responsible for much of Hong Kong's import trade, and we may deal with other countries in less detail.

Supplies of borax and saltpetre are drawn primarily from India and are shipped to South China, the value of saltpetre imported in 1921 being £112,412 (3,354 tons). Germany is the chief supplier of potassium chlorate, the import being 498 tons valued at £30,666; and also of aniline dyes, the total value of which amounted to £124,277. South China is the chief market for both these products, but it should be added that the competition of the United Kingdom and Japan is evident in the case of the latter product, while Germany is only in the third place as a supplier of synthetic indigo, the United States and the United Kingdom both sending in a larger proportion of the total import of 6,040 hundredweights. Mid-China and South China are the chief buyers of synthetic indigo.

The United States is also the largest supplier of asphalt products, which are in demand in French Indo-China, but tar is imported from North China and sent on to the South, as also is salt (56,260 tons). Chinese alum is largely re-exported to the Straits Settlements, and, finally, quinine from the Dutch East Indies is in demand for Hong Kong's greatest customer, South China.

The colony, so far as can be seen, does not act to any large extent as a collector of chemical produce for European consumption, but part of its imports of camphor is absorbed by the United Kingdom, and it also supplies a certain amount of nux vomica, which is originally bought from French Indo-China.

It should be added that it does not seem possible to get a fair idea of local consumption from the figures available, but it would seem that any proportion of the imports retained for local use consists largely of such products as salt, opium, dyestuffs, etc.

ADEN AND SOCOTRA

It does not seem necessary to deal at any great length with Aden in this volume. Its chief *raison d'être* is its importance as a coaling station and as an entrepôt, and our interest may be said to lie in the latter connection.

The imports, however, are quite insignificant in so far as they are noted, the chief headings in 1921 (year ending March 31, 1922) being naphthalene (3,071 hundredweights), aniline dyes (12,144 pounds), and certain potassium compounds of which the details are not given (5,709 hundredweights).

Very little detail is available in regard to the export trade in the products with which we are dealing, but the leading articles instanced in the statistics are potassium compounds; sodas other than borax; asafœtida, and aloes. Salt should be mentioned in more detail, as Aden is here a producer. The total quantity exported in 1921 was 150,851 tons, practically all to the Empire.

Aniline dyes also are re-exported, and Aden buys chiefly from India and the United Kingdom; the chief customers for chemical products are naturally enough the areas in the nearer vicinity.

We have included Socotra with Aden as it is under the Aden Government, and it is worth mentioning as a supplier of aloes. We have not succeeded in tracing any statistics in this connection.

SECTION III.—AFRICA

CHAPTER XIV

THE UNION OF SOUTH AFRICA

§ 1.

THE Union of South Africa consists of the provinces of the Cape of Good Hope, Natal, the Transvaal, and the Orange Free State. Its importance in the Empire as a producer of manufactured articles is not yet very considerable, as may be gauged from the fact that its total manufacturing production (value added to raw materials by process of manufacture) figure for 1920-21 is given as £40,342,639. The share of the chemical group in this total is £2,067,712, but as the official group-heading covers, in addition to the articles with which this volume is concerned, the manufacture of explosives—an important branch of South African activity—matches, oil and grease, paints, varnishes, soap and candles, it may safely be assumed that the manufacture of heavy and pharmaceutical chemicals, coal tar products, etc., is as yet in its infancy in the Union.

Possibly a more accurate idea of the importance of the industry in South Africa may be gained from the fact that chemicals and drugs, salt and fertilizers, together account for only about £46,000 out of a total export of £62,381,209 of Union produce in 1921. South Africa is, therefore, a buyer at present in so far as chemicals are concerned, and the total value under the headings to which we have just referred imported in 1921 was about 1¾ million pounds.

It may be added that fertilizers account for, in round numbers, £31,000 out of the £46,000 which we have mentioned above, and we shall, therefore, deal as fully as possible with this section of the export trade of the Union.

§ 2.

The chief industrial areas of South Africa are the Cape of Good Hope and the Transvaal, with a total of 3,048 and 2,355 factories respectively in 1920-21; the order, however, is reversed in the case of the chemical group (including paints, etc., as noted above). Here we find forty establishments in the Transvaal, thirty-eight in the Cape, thirty-four in Natal, and only two in the Orange Free State, while the chief centres of industrial activity are Witwatersrand with thirty-eight works, Durban district with twenty-seven, and the Cape Peninsula with twenty-five factories noted in this group.

The Union Office of Census and Statistics is at Pretoria, and is obviously an efficiently organized department which will play an important part in the future development of local industry. It is natural, however, that, in view of the relative importance to the Union of Mining and Agriculture, the statistics relating to these two sections of the country's trade should be fuller than those relating to manufacturing industry, and especially the chemical section thereof.

It may be added that the external trade statistics to which we are coming later apply to the calendar years and do not include goods from or to Northern and Southern Rhodesia, which are only entered as "lumped" totals. The figures may also be to some extent inaccurate, owing to the fact that the imports and exports of Government stores are entered in a separate table, but wherever possible we shall include these items in our statistics, unless the value involved is comparatively unimportant.

§ 3.

South Africa, like the other great Dominions, is rich in the natural resources needed for the production of chemicals. Such materials as copper, lead, tin, pyrites, lime, manganese, salt, and magnesite are produced commercially, and deposits are noted of barytes, chromium, arsenic, antimony, phosphates, soda and potassium nitrate.

Coal is found in all the four provinces of the Union, the chief producer at present being the Transvaal, while it is estimated that the water power available in South Africa as a whole amounts to 43·3 per cent. of that of the whole world.

§ 4.

We have not been able to trace tabulated production tables of much value for the subject with which we are dealing, but we have obtained figures for certain products, and it will also be convenient to include in this section some notes as to the chemical products at present being manufactured in the Union.

In the official list of industrial establishments we find six works producing acids, seven for ammonia, eleven for various sodium products, twenty manufacturing chemists, thirteen chemical manufacturers, and twelve tar and pitch works, together with thirty-seven fertilizer works and a number of producers of other named chemicals. It must be understood that a number of works produce several of these articles, and, therefore, appear more than once in the list, but the foregoing will give an idea of the present scope of the local industry.

Turning now to the weights of the local production, we have, as is to be expected, most particulars regarding the fertilizer section, in which "Mixed Fertilizers" is the largest heading. The information is arranged according to the composition of the product, and is as follows:

Production of Mixed Fertilizers in the Union of South Africa, 1920–21.

Nitrogenous and phosphatic fertilizers	3,838 tons
Potassic and phosphatic fertilizers	193 „
Nitrogenous and potassic fertilizers	320 „
Nitrogenous and phosphatic and potassic fertilizers	20,772 „

The production of nitrogenous organic fertilizers is given as 3,760 tons, of bone meal as 11,782 tons, and of superphosphate (a comparatively recent development of the industry), as 5,731 tons, while other manures produced are valued at £167,691, the total value of all these in 1920-21 being £616,414. Other

fertilizer production figures for the year 1921 are sulphate of ammonia, 918 tons, and guano, 8,548 tons (estimated).

The former is apparently the product of one works only, while the latter is from the Government guano islands situated around the western and southern parts of the South African coast, and the local demand is such that export is not allowed.

Other production figures are, for the year 1921: tar, 46,085 gallons; salt, 68,379 tons; and for 1920-21, glycerine and soda crystals from soap and candle factories, 755,305 and 2,573,058 pounds respectively; while it is also stated that approximately 400 tons per month of sulphur are produced from the auriferous concentrates from certain mines, the balance of the demand of about 1,500 tons per month being filled by imports. Finally, a quantity of 312 tons of soda is noted as the production for 1921, apparently from a natural deposit at the Pretoria Saltpan.

We may now turn to the external trade of the Union, and it should be noted that the exports of home produced chemicals are so insignificant that we have not thought it worth while to distinguish in general between exports and re-exports. When, however, any considerable part of the quantity sent out is local production, a note will be made to that effect.

§ 5.

Heavy Chemicals.

The largest locally produced export of this type, although not strictly within our province, is argol, of which 209,133 pounds, valued at £4,505, were sent out in 1913, and 344,039 pounds to a value of £2,233 in 1921, the United Kingdom being the largest buyer in both years; while the only other articles in this group worthy of mention, from the point of view of local production, are salt, common and table, with a figure for 1913 of 93,736 pounds, and for 1921 of 1,394,114 pounds, the bulk in both years being Union produce, and glycerine, the figures for which are rather remarkable. In 1913 South Africa exported 1,668,235 pounds of this material, by far the larger part being home produced; in 1921, the quantity had fallen to 346 pounds, almost entirely re-exported. The bulk of both products went to foreign countries.

The remaining exports—primarily re-exports—to which we must refer in this group are shown in the table on p. 125.

Turning now to the import statistics relating to this group, the number of headings has, as in most other countries, been increased in the interval between the two years with which we are dealing. In 1921 we find fairly considerable imports (with no corresponding information for 1913) of boric acid (103,736 pounds), white-lead (1,801,903 pounds), sodium silicate (1,697,041 pounds), and sodium arsenite (914,848 pounds), the Empire being the chief supplier in the case of the first three articles, and the sole source of the last named.

Considering now the comparison between pre-war and post-war trade, the articles of chief interest scarcely fall into any rational groups, and we will, therefore, deal with them in an arbitrary manner.

Sulphuric acid, excluding Government stores, which amounted to 2,910 pounds in 1921, to a total of 291,976 pounds was imported largely from the United Kingdom in 1913, while the quantity in 1921 was only 22,940 pounds, the chief source being the same; and borax is another chemical in which the United Kingdom has held its own, the pre-war total being 827,810 pounds against a corresponding figure for the later year of 287,610 pounds.

EXPORTS OF CERTAIN HEAVY CHEMICALS FROM THE UNION OF SOUTH AFRICA (LBS.).

Product.	*Destination.*	1913.	1921.
Sulphuric acid	Empire	Nil	219,396
	Foreign countries	4,660	584,958
	Total	4,660	804,354
Other acids	Empire	1,098	5,611
	Foreign countries	166	2,503
	Total	1,264	8,114
Caustic soda	Empire	Nil	29,898
	Foreign countries	2,144	24,335
	Total	2,144	54,233
Other sodium compounds	Empire	2,790	53,034
	Foreign countries	10,088	27,578
	Total	12,878	80,612
Calcium carbide	Empire	6,140	33,908
	Foreign countries	39,770	14,732
	Total	45,910	48,640

Ammonia for ice-making is entered in 1913 at £4,811, about three-quarters of this being Empire produce, and anhydrous ammonia in 1921 totalled £9,589, but foreign countries at £3,758 had secured a larger share of the trade.

It may, perhaps, be advisable to give salt, caustic soda, and cyanide of sodium in greater detail, as they are fairly important products, and the comparative particulars for the two years are shown on p. 126.

The value of the last named in 1913 was £395,639, and in 1921, £326,679, while another article of large value is glycerine, of which a total of 16,662,384 pounds, valued at £563,014, was imported in the earlier year and 9,051,289 pounds, valued at £436,715, in the later. The chief source of supply changed from various foreign countries, especially Holland, in 1913 to the Empire, in 1921.

IMPORTS OF SALT, CAUSTIC SODA, AND CYANIDE OF SODIUM INTO THE UNION OF SOUTH AFRICA (LBS.).

Product.	*Source.*	1913.	1921.
Salt	Empire	17,713,379	1,983,711
	Foreign countries	2,558,065	3,814,661
	Total	20,271,444	5,798,372
Caustic soda	Empire	5,240,895	2,400,753
	Foreign countries	8,803	36,782
	Total	5,249,698	2,437,535
Cyanide of sodium	Empire	3,979,830	5,588,320
	Foreign countries	7,615,154	16,325
	Total	11,594,984	5,604,645

We will conclude this section with a table showing in detail the situation in tartaric acid, cream of tartar, and carbide of calcium, three products of which fair quantities are imported, but there are in addition two other articles of interest —namely, potash compounds not otherwise designated, which totalled up to £12,909 in 1913 and £12,767 in 1921, and nitrates for manufacturing purposes, the quantities being 54,517,475 pounds (£235,984) and 48,390,424 pounds (£361,118). As Chile is the main source of supply in both years, it would seem that the product is chiefly nitrate of soda. If this is so, South Africa is the only country in the Empire which distinguishes between sodium nitrate for fertilizing and for manufacturing.

IMPORTS OF CERTAIN CHEMICALS INTO THE UNION OF SOUTH AFRICA (LBS.).

Product.	*Source.*	1913.	1921.
Tartaric acid	Empire	36,599	30,363
	Foreign countries	64,194	27,398
	Total	100,793	57,761
Cream of tartar	Empire	36,742	8,838
	Foreign countries	156,793	52,817
	Total	193,535	61,655
Calcium carbide	Empire	1,636,165	1,787,176
	Foreign countries	7,962,220	2,422,777
	Total	9,598,385	4,209,953

§ 6.

Coal Tar Products and Dyestuffs.

The only export headings we have been able to trace in this group are tar and pitch in 1913, to a value of £142, and the same articles together with asphalt and bitumen valued in 1921 at £1,639, £807 of this latter figure being for local produce, chiefly pitch. It is possible, however, that disinfectants and germicides (1913 value £268, 1921 value £4,174) should also be included in this group.

Turning now to the import side, the doubtful heading of disinfectants and germicides is by far the largest item, at £43,272 in the pre-war year, while in the later year the heading was further particularized and disinfectants alone account for £48,884. It may be added that in both years the United Kingdom is the only supplier of any consequence.

We will give in a table below the remaining information relating to this section, apart from dyes. In order to save space only total quantities will be noted, and it will suffice to say that the United Kingdom is undoubtedly the biggest individual supplier in this group.

Imports of Various Coal-Tar Products, etc., into the Union of South Africa (Lbs.).

Product.	1913.	1921.
Asphalt and bitumen	4,359,707	2,303,768
Creosote	335,387	341,170
Pitch	446,118	321,338
Tar	13,088,036	5,723,881
Tar substitutes	—	1,326,288

As far as dyestuffs are concerned, no separate heading is to be traced, and colours for textile and leather must come in a bulked class with certain tanning and similar substances, which would apparently imply no great demand or re-export.

§ 7.

Fertilizers.

We now come to the group which may be said to constitute South Africa's sole claim at the present time to be considered as an exporter of the chemicals with which we are concerned, and all the particulars available are set out in the table on p. 128.

It will be observed that sulphate of ammonia was not noted separately in 1913, and for purposes of comparison it should, therefore, be added in with other manures in 1921.

EXPORTS OF FERTILIZERS FROM THE UNION OF SOUTH AFRICA (LBS.).

Product.	Destination.	1913.	1921.
Bone meal	Empire	—	2,000
	Foreign countries	2,000	1,600
	Total	2,000	3,600
Whale manure	Empire	604,200	921,048
	Foreign countries	854,700	—
	Total	1,458,900	921,048
Sulphate of ammonia	Empire	—	3,064,000
	Foreign countries	—	—
	Total	—	3,064,000
Other manures	Empire	—	38,148
	Foreign countries	302,200	118,932
	Total	302,200	157,080

Passing on now to the Union's purchases in this group, we find ample information to be available, and we will give, in the first place, the details relating to phosphatic manures:

IMPORTS OF PHOSPHATIC MANURES INTO THE UNION OF SOUTH AFRICA (LBS.).

Product.	Source.	1913.	1921.
Basic slag	Empire	1,712,278	22,400
	Foreign countries	10,227,280	3,787,010
	Total	11,939,558	3,809,410
Raw phosphates	Empire	312,913	13,543,040
	Foreign countries	1,209,520	11,677,120
	Total	1,522,433	25,220,160
Superphosphate	Empire	5,935,595	1,128,677
	Foreign countries	76,091,341	21,695,804
	Total	82,026,936	22,824,481
Guano	Empire	625,093	2,171,228
	Foreign countries	76,460	2,469
	Total	701,553	2,173,697

It is stated that South African soil is more deficient in phosphoric oxide than in other fertilizing agents, and the four fertilizers named above are, therefore, the largest imports. Other headings of some moment are, however:

	1913 (*Lbs.*).	1921 (*Lbs.*).
Bone manures	9,427,746	1,731,112
Potash manures	3,994,560	1,560,000
Sulphate of ammonia	799,075	967,985

In the case of the first named the Empire did rather less than half the trade in the pre-war year, but in 1921 the honours went to Madagascar and Germany, while potash manures were largely German produce in both years, and sulphate primarily British in the earlier year. Unfortunately, however, Holland gained the bulk of the post-war business.

Nitrate of soda is obviously not in much demand for direct use as a fertilizer in the Union, the quantities brought in in both years being quite insignificant. We may now conclude this section by saying that the total of other manures imported in 1913 was 17,169,069 pounds (£35,233), and in 1921, 726,448 pounds (£4,276), the United Kingdom supplying £15,375 before and £1,446 after the War.

§ 8.

Fine Chemicals, Drugs, and Medicinal Chemicals.

It is scarcely to be expected that South Africa should figure largely as an exporter under this heading, and the only article connected with this group which we wish to mention is aloes, of which 549,504 pounds were sent out in 1921, the largest buyers being Germany and the United Kingdom. The corresponding total for the pre-war year is 702,958 pounds, but in this case the United Kingdom took more than twice as much as Germany.

Little detailed information is available regarding the products imported in this group, but we find that the Union bought 654 pounds of opium in 1913, and 741 pounds in 1921, the Turkish Empire being the chief supplier in both years, while the demand for saccharin has increased considerably in the period under review. This trade is primarily in the hands of the United Kingdom, which sent in 77 pounds, valued at £208, the total quantity imported in 1913, against 3,010 pounds out of a total import for 1921 of 3,565 pounds. It is interesting also to observe that the value in the earlier year was roughly 54s. per pound, but after the War it averages under 20s. per pound.

§ 9.

The import trade in South Africa is partly in the hands of merchant houses, but some manufacturers of chemicals either have buying offices in the United Kingdom or are allied with British manufacturers, and therefore are able to import direct on their own account, and a consumer who is in a position to

buy in fair quantities will usually tend to put himself in direct touch with the producing works.

Turning now to the needs of specific trades, agriculture, of course, comes first with its demands for fertilizers. We find butter and cheese factories using, in 1920-21, 655,051 pounds of salt and other chemical substances; refrigerating works which turned out in the same year 61,343 tons of ice; soap and candle factories consuming chemicals to a value of £92,295, together with 28,430 pounds of dyes; tanneries which used dyeing materials to a value of £6,042, and, doubtless, considerable quantities of chemicals also; and wool washeries which are noted as consuming alkali to a value of £5,280.

The import of glycerine is, doubtless, largely accounted for by the explosives industry, a fairly considerable branch of Union manufactures, while we also note references to glass works, a number of paint and varnish works, and various other users of chemicals.

§ 10.

Our acknowledgments are due to the *Union Year Book* and other official literature for much of the information given in the foregoing sections, while we may add that we have received very ready assistance from various members of the High Commissioner's office in London.

We have devoted, perhaps, rather more space to this survey of the Union of South Africa than is strictly warranted by the importance of the Union as a present producer and buyer of chemicals.

We feel, however, that less is generally known in the chemical industry of the United Kingdom regarding South Africa than the other large Dominions, and we have, therefore, thought it well to deal fairly fully with our subject. We also think that the Union chemical industry may before very long show signs of considerable expansion, especially in regard to the production of fertilizers and tar products.

CHAPTER XV

THE GAMBIA. SIERRA LEONE. THE GOLD COAST AND ASHANTI. NIGERIA. NYASALAND

THE GAMBIA

THE chief article of export of this Colony is ground nuts, though hides, to a certain value, are also sent out, while it appears that no mining or other industry is carried on.

The chemical trade, as may be expected, is negligible, the chief import being salt, which was bought from Portuguese colonies in 1913 and from the Cape Verde Islands in 1921. A little of this is re-exported to near-by Colonies, while the import of drugs and chemicals for the pre-war year is given as £2,661, and of

drugs and medicines for 1921 as £3,667. Chemical manufactures and products accounted for £311 in addition.

The only article of local production that we can trace is an export to the United Kingdom in 1913 of bones and horns valued at £30.

SIERRA LEONE

In this section of the Empire there is no industry to call for the import of chemicals. The chief products exported are such articles as palm kernels, ground nuts, hides and other natural products, while cotton is grown by the natives.

Certain districts are stated to be suitable for growing rubber and other commodities of a like source, but the only mineral found so far is iron, and this is apparently not worth working.

The only chemical we note imported by name is salt, of which 6,070 tons were bought in 1913 and 3,685 tons in 1921. A small quantity is re-exported to near destinations such as Liberia.

THE GOLD COAST AND ASHANTI

The chief exports of this colony are gold and cocoa, though other natural products, including palm kernels and rubber, are shipped. Such industry as exists is of the order of rough weaving, metal work, and the manufacture of household necessities such as pottery, but no form of organized effort has been brought to our notice. Rough salt, however, is to some extent produced.

The chief imports are: indigo blue (382,173 pounds in 1913, and 380,710 pounds in 1921), which would seem to bespeak a fair amount of dyeing; tar to the value of £1,486 and £3,061 (this latter total includes pitch); and other drugs and chemicals, £33,650 in the earlier year and £54,193 in the later. The specified drugs, etc., are insignificant, so these last figures may be taken as showing the total chemical imports to an accurate enough extent, apart from salt, which accounts for £29,251 in 1921, the quantity being 70,042 hundredweights.

No exports worth mentioning are noted, but a small re-export business was done with Sierra Leone in 1921. Practically all the chemical imports listed are from the United Kingdom, but some part of the indigo blue came from Germany in the pre-war year.

NIGERIA

The Colony and Protectorate of Nigeria is of considerable area (about 335,000 square miles) and is of some importance from a commercial point of view, the total exports of local production in 1920 amounting to nearly £17,000,000. Its progress has been considerable over the last ten to fifteen years, and this is, perhaps, the more remarkable in view of the fact that the climate is far from satisfactory for Europeans, which would seem, apart from other reasons, to militate against the likelihood of there ever being any large consumption of chemicals other than drugs.

The staple articles of export are such natural products as palm kernels, cotton, rubber, hides, and tin, while crops of various sorts are grown and stock-raising is carried on. Tin-working is the chief mineral industry, but lignite and coal are also found, and the latter is mined by the Government.

A certain number of chemical headings appear in the statistics, the largest import being salt, of which 730,747 hundredweights were imported in 1913 and 770,441 hundredweights in 1921. Other articles worthy of mention are calcium carbide, of which the import has grown from 83½ to 1,126 hundredweights, quinine and its salts (£365 and £3,737), and pitch and tar (3,631 and 3,926 hundredweights), together with dyes and dyestuffs to a value of £1,562 (25 hundredweights) in 1921.

The chief export noted is potash, of which 1,425 hundredweights, valued at £1,445, were sent out in 1913, the corresponding figures for 1921 being 1,904 hundredweights (£3,495).

Chemicals other than manures and medicines imported in 1921 were valued at £10,831, and the main source of supply in both years is the United Kingdom.

NYASALAND

The Nyasaland Protectorate is totally unimportant as a buyer of chemicals, and it can only deserve mention in this volume as a producer of tea, from the refuse of which caffeine is made.

The only named import of value in the section with which we are dealing is salt to the value of £1,041 (17,028 bags), in 1913, from Portugal and Portuguese East Africa, while the quantity brought in for 1921 is given as 11,770 hundredweights, valued at £1,890. There are apparently no chemical exports.

CHAPTER XVI

THE SOUTH-WEST AFRICA PROTECTORATE. THE SOUTH AFRICAN HIGH COMMISSION

THE SOUTH-WEST AFRICA PROTECTORATE

THIS area, the capital of which is the town of Windhoek, only became a part of the Empire as a result of the War, and the statistics with which we can deal are, therefore, only for the year 1921.

The chief production of the country is from stock-raising and mining, and the natural resources, so far as they are prospected, are very much on the lines of those of the Union of South Africa, with which we have already dealt. Manufacturing is, of course, as yet in its infancy, the total number of establishments of all sorts noted being only 112 in the year 1921, and none of the named sections are of interest from the chemical point of view.

The exports consist chiefly of natural products of the order of mineral ores and articles of food and drink, etc., the only heading of interest to the present

volume being manures other than whale manure, of which 1,205,740 pounds, valued at £3,481, were sent to the Union in 1921, all being local produce.

Turning now to the imports, we find the chemical section to be very small. Salt is, as usual, one of the largest items at £1,769, while others are:

Calcium carbide	52,972 lbs.	Sulphur	61,607 lbs.
Caustic soda	30,958 „	Tar and substitutes	19,615 „
Sheep and cattle dips	£3,224		

The Empire seems to get a fair share of the trade, but it would appear that the German occupation has left its influence behind it in the form of a tendency in some quarters to buy from Germany wherever possible.

THE SOUTH AFRICAN HIGH COMMISSION

The areas dealt with under this heading will be the countries of Basutoland and Swaziland and the Bechuanaland Protectorate.

The South African High Commissioner is Governor of Basutoland, exercises a certain control over what was the administration of the British South Africa Company in Northern and Southern Rhodesia, and supervises the affairs of Swaziland and the Bechuanaland Protectorate. No statistics are kept in the case of Bechuanaland and Swaziland.

The former collects no duty for itself, with the exception of that on goods from the South-West Africa Protectorate, receiving instead an allowance from the Treasury of the Union of South Africa, and a similar arrangement is in force in the case of Swaziland.

Some statistics are available for Basutoland, but we have succeeded in tracing no mention of chemicals therein. It will, therefore, be obvious that these countries are not of importance to the present volume from a commercial point of view, but a short account of their present trade and resources may not be out of place as giving some indication of future possibilities.

Basutoland is an agricultural and pastoral country, the chief exports being stock, wheat, maize, wool, and mohair, of which the largest individual item is apparently wool, to a value of about £211,981 in 1921, a certain quantity of hides and skins being also sent out. There are no mines in the territory, and but little is known of its mineral resources, as the native population is averse from prospecting of any kind.

The Bechuanaland Protectorate is primarily devoted to stock-raising, though quantities of certain grains are reaped in a favourable season; the rainfall, however, is too uncertain to allow any large pursuit of agriculture. A certain amount of mining (for gold and silver) is carried on on a small scale, and the imports consist, at present, chiefly of articles of household use and clothing, etc. It is to be surmised that proper prospecting of the territory has yet to be carried out.

Swaziland is, again, largely a stock-raising country, but tin-mining is also carried on, the output for 1920 being 410 tons. Other minerals are known to exist, including coal, but, apart from gold, nothing has apparently been done in the

direction of working the resources. Agriculture may apparently be expected to expand as time goes on, more especially when railway facilities are available, and the growing of cotton has been started.

It would, therefore, appear from the information available that the chief prospects in these three areas lie, from the point of view of this volume, in the possible export of raw materials and the import of fertilizers. It would seem, however, that many years must elapse before there is sufficient population to give rise to much demand for any chemicals.

CHAPTER XVII

NORTHERN AND SOUTHERN RHODESIA

SEPARATE statistics are available for Northern and Southern Rhodesia, and it is natural that the section nearer the Union of South Africa should be the more important.

The general position of trade in these two areas is shown approximately in the following table:

COMPARATIVE GENERAL STATISTICS FOR NORTHERN AND SOUTHERN RHODESIA (THOUSAND £).

	1913.				1921.			
Country.	*Total Imports.*	*Chemical Imports.*	*Total Exports.*	*Chemical Exports.*	*Total Imports.*	*Chemical Imports.*	*Total Exports.*	*Chemical Exports.*
Northern Rhodesia	263	3	232	·06	741	12	565	—
Southern Rhodesia	3,018	82	3,505	2	5,243	170	4,815	18

The figures given as exports include re-exports, and it will be realized that the importance of these countries, from a chemical point of view, lies in the future. Such export trade as is carried out consists primarily of re-exporting to the Belgian Congo, Portuguese East Africa, etc., and in the case of Southern Rhodesia to the Northern area, the only article worthy of note being white arsenic, local produce, of which 507,884 pounds, to a value of £8,411, were exported from Southern Rhodesia in 1921.

A little salt also is sent out from both the Southern and Northern areas, while in the former the imports run very much on the lines of those for the Union of South Africa, but naturally in smaller quantities. The largest individual item is sodium cyanide at £36,202 for 1913 and £54,278 for 1921, while other considerable totals for the latter year are:

Sulphuric acid (523,207 lbs.) ..	£5,890	Manures	£18,846
Salt	9,056	Sheep, etc., dip	27,750

In Northern Rhodesia the biggest items are salt at £2,818 and sheep and cattle dips at £2,592, both in 1921. The imports in 1913 were negligible, salt being the only article of any noticeable value.

Government stores for both areas are simply given under the heading "Drugs and Chemicals," and totalled £7,430 in 1921, the quantity being insignificant in the earlier year. In addition a small quantity of tar and pitch was brought in on Government account.

Northern and Southern Rhodesia are, of course, largely mining, pastoral, and agricultural countries, and any chemical manufacturing industry seems a thing of the far distant future, if it is ever to come at all.

CHAPTER XVIII

THE KENYA COLONY AND PROTECTORATE. SOMALILAND

THE KENYA COLONY AND PROTECTORATE

THE area which will be dealt with under this heading includes the old East Africa Protectorate and also Uganda, and the statistics for the pre-war year are given separately.

We need not, however, deal at any length with the import trade in either year, as the headings are not of an informative character. It will be enough to say that the total import of chemicals, etc., is considerably heavier in 1922 than it was before the War, and the largest named item in both years is salt, at 143,396 hundredweights in 1913 and 81,209 hundredweights in 1922.

The present exports of the Colony are primarily of an agricultural character, such as cotton, coffee, etc., and the mineral resources have not been fully prospected. Iron and limestone, however, are known to occur, and the latter is worked, but the chief natural resource of interest to this volume is the deposit of soda at Lake Magadi, in the south of the Colony.

As is well known, this is worked by a company having headquarters in London, and progress is shown by the fact that the export of carbonate of soda noted in 1913 is 332 hundredweights, against a total of 48,710 tons for 1922. The market was local in the pre-war year, but is now world-wide, Japan being the chief buyer in 1922.

The only other local product we need mention is salt, of which 5,900 hundredweights were sent to near destinations in 1922. A little re-export trade is also done, but not in sufficient volume to be worth considering here.

It should be noted that the above post-war statistics are all for 1922, as those for the previous year are not so satisfactory owing to alterations in the period of return.

SOMALILAND

The chief industry of this area is the raising of sheep and cattle, and the exports consist chiefly of the live animals and natural products of one sort and another.

Somaliland, however, is a producer of salt, a small quantity being exported to near localities before the War, and the total production is given for 1912-13 as 850 tons.

It is stated that white rock salt and traces of other minerals have been found, though these are apparently not yet worked. The only other local productions we have been able to trace are bones and guano, small quantities of both being sent out, the former to Aden and the latter to nearer destinations.

CHAPTER XIX

MAURITIUS AND DEPENDENCIES. THE SEYCHELLES ISLANDS. ZANZIBAR AND PEMBA

MAURITIUS AND DEPENDENCIES

A LARGE number of islands are included in the Dependencies of Mauritius, but so far as this volume is concerned, the only ones of interest are St. Brandon and Farquhar Islands, from which Mauritius imports supplies of guano, the total quantity in 1913 being about 854 tons.

Turning now to Mauritius itself, the island deserves our consideration both as a serious buyer of chemicals and for the very informative nature of its official statistics, as will appear below.

The island of Mauritius is almost entirely dependent on the sugar-growing industry, and fertilizers and products for their manufacture loom large in the import returns. Other chemical supplies to a considerable value are, however, needed, as is natural enough for a population of well over 370,000, but the only exports entry noted for home produced material refers to a small quantity of salt in 1913. A certain amount of re-export is also carried on with the Seychelles, etc., but the total value is insignificant.

Turning now to the import returns, we find two special class headings, detailing chemicals used for local manufactures and chemicals for the preparation of manures. We will give, in the first place, the particulars relating to the chief products used for local industry, and in order to save space as far as possible the total imports only will be shown in this and the subsequent table for Mauritius, the column headed " Source " referring to the largest supplier in the year in question. It should be added that the original statistics are in kilogrammes, and the quantities will, therefore, be given to the nearest ton or hundredweight.

IMPORTS OF CERTAIN CHEMICALS USED IN LOCAL MANUFACTURES INTO MAURITIUS (CWTS.).

Product.	1913.		1921.	
	Quantity.	*Source.*	*Quantity.*	*Source.*
Sulphuric acid	261	United Kingdom	264	United Kingdom
Hydrochloric and phosphoric acids	3,801	United Kingdom	239	United Kingdom
Superphosphate of lime	1,858	United Kingdom	No statistics	
Phosphate of lime ..	984	Belgium	No statistics	
Carbonate of ammonia	37	United Kingdom	51	United Kingdom
Sodium carbonate and caustic	175	United Kingdom	256	United Kingdom

It will be observed that the United Kingdom has succeeded in holding its trade in so far as this class is concerned, and it may be added that quantities of sodium silicate were imported in 1913 and of sodium phosphate in 1921.

Considering now the manure group, we should regard the heading as more accurate if it were simply fertilizers. The chief details are as follows:

IMPORTS OF FERTILIZERS INTO MAURITIUS (TONS).

Product.	1913.		1921.	
	Quantity.	*Source.*	*Quantity.*	*Source.*
Sulphate of ammonia ..	5,235	United Kingdom	8,868	United Kingdom
Superphosphate, etc. ..	1,091	United Kingdom	1,226	Belgium
Nitrate of lime	177	United Kingdom	75	Norway
Nitrate of potash ..	2,050	India	3,242	India
Nitrate of soda	531	United Kingdom	3,018	Chile
Bones, blood, tankage, etc.	1,394	United Kingdom	462	South Africa
Guano	1,213	South Africa	237	Seychelles

It will be observed that certain changes in the direction of trade have occurred in the period under review, and we would add that the last two items are shown separately from the group-heading to which we have referred; this would seem, however, largely a distinction without a difference. The only other considerable item in this section is the guano from the Dependencies which we have already noted.

Space does not permit us to deal at length with other headings in the Blue Book, and it will suffice to say that small quantities of sulphuric and hydrochloric acids and caustic soda are imported additional to those named above, while the chief other articles noted are salt (3,217 tons in 1913, and 124 tons in 1921), sulphur (988 and 1,344 tons from France in both years), carbolic acid (26 and 8 tons), and camphor, the refined and crude totalling together 84 and 62 hundredweights respectively for the years under review.

Other imports are pitch and tar, boric acid, copper sulphate, etc., together with a fair value of opium from India in 1913, and of quinine preparations from the United Kingdom in 1921; also 159 hundredweights of synthetic indigo from Germany in 1913, the 1921 quota of 105 hundredweights coming from France.

Apart from exceptions specially noted by us, it may be taken that the United Kingdom is the chief supplier both before and after the War for the products we have mentioned.

THE SEYCHELLES ISLANDS

The Seychelles group consists of a considerable number of islands, the chief of which is Mahé.

The import trade in chemicals is insignificant, consisting of small quantities of such articles as caustic soda, washing soda, and sodium silicate, pitch, tar, and a little opium and camphor. The largest weight is salt at 19 tons in 1913, and 97 tons in 1921, the chief source being Aden in the earlier year and India in the

later, while the largest value imported is caustic soda in both years, the United Kingdom being the chief source of supply.

The claim of the Seychelles to consideration in this book lies, however, in their exports of guano. As is well known, considerable deposits of this material exist, and the value of the quantity exported in 1913 is nearly half of the total exports of the islands.

The chief buyers of this guano in 1913 were Belgium, the United Kingdom, Holland, and New Zealand, the quantity exported being 34,720 tons, while in 1921 the United Kingdom took 5,000 tons out of a total export of 6,419 tons, other buyers being South Africa, Belgium, etc. Apart from their importance as producers of guano, there does not appear to be much prospect of these islands buying or selling any considerable quantities of chemicals.

ZANZIBAR AND PEMBA

The importance of these islands in the Empire's resources may be said to lie in their production of cloves, and to some extent copra.

The chemical trade is very small, the only entry for 1913 being the import of 37,268 bags of salt, valued at £2,180. In 1921 more information is available, chemicals unenumerated accounting for £7,047, the named imports being quinine and preparations thereof (1,691 ounces), dye and dyestuffs (17 hundredweights), etc. Salt was the largest weight, at 630 tons. At £607 it was second in value of the named products only to quinine, which was entered at £918.

A certain amount of re-export was carried on in the articles enumerated above, and the largest items in the export section of the statistics are salt (654 tons, value £1,405) and chemicals unenumerated, which are entered at £1,281.

CHAPTER XX

EGYPT

EGYPT is, of course, no longer a part of the Empire, and it is not, therefore, entitled to protracted consideration in this volume. It remains, however, a large buyer of chemicals, and some small account of the situation in 1921 will, therefore, not be out of place.

Far and away the largest share of the Egyptian export trade is contributed by raw cotton, and the quantities of fertilizers imported cover a considerable value. Nitrate of soda shows 34,629 tons, nitrate of lime 3,107 tons, and superphosphate 3,517 tons, the Empire having practically no share in the supply of these three articles. Sulphate of ammonia, however, came entirely from the United Kingdom to a total weight of 1,737 tons, while other chemical fertilizers are not of any importance.

Turning now to the heavy chemical section, we find, as is to be expected, that the largest heading is sulphuric acid at 2,833 tons, and it is pleasing to see that

the better part of this came from the Empire. A very different state of affairs is in force with other acids, our share being very small. The most valuable total next to sulphuric acid is tartaric, with 35 tons, and the Empire's share is insignificant.

In alkalies the largest item is caustic soda, at 1,198 tons, and here the United Kingdom supplied more than half, while soda crystals and soda ash are also of some magnitude, the Empire's proportion being much the same.

Alum and aluminium sulphate, etc., are largely to the United Kingdom's credit, our share being 1,382 tons out of a total of 1,585 tons, and the same may be said of sal ammoniac, the figures being 189 and 204 tons respectively.

Passing to the coal tar and dyestuffs section, however, the Empire's share is of very little account. Our proportion of a total import of 1,247 hundredweights of coal tar dyes, 6,185 hundredweights of synthetic indigo, and 3,391 hundredweights of aniline salt, is only 113, 675, and 322 hundredweights respectively, though the position is rather better in the case of naphthalene, where we contributed about one-third of the total quantity of 862 hundredweights. The value, however, of this is, unfortunately, insignificant by comparison with the remainder of the group.

The final import which should be noted here is opium, and it is not surprising that foreign countries should be the chief suppliers in this direction. The quantity was 15,640 pounds, out of which the Empire sent in 142 pounds only.

Turning now to the export trade, the only three headings we need mention are shown in the following table.

EXPORTS OF CERTAIN CHEMICALS FROM EGYPT IN 1921 (TONS).

Product.	*Empire.*	*Foreign Countries.*	*Total.*
Salt	120,633	30,757	151,390
Caustic soda	Nil	1,206	1,206
Phosphate of lime	10,240	69,930	80,170

The first and the last represent Egypt's chief claim to note in this volume as a country of natural chemical resources, although other chemical raw materials are found.

We do not think it necessary to comment on the production of salt, as the value of this is not very great, but a few particulars as to the phosphate deposits may be of interest.

Phosphate of lime appears to occur in a number of districts in Egypt, but the quality is on the whole not high enough to pay for exporting. The chief sources for the material exported are near Port Safaga and the Gebel el Qurn plateau, and other payable deposits are in the Sibaia and Dakhla districts. Enormous quantities of lower grade material are, however, available for local consumption, but no large demand is so far reported.

The re-export trade of which statistics are noted is inconsiderable so far as concerns the products with which we are dealing, and it will be sufficient to say that most of the chemicals imported are also to some extent sent out of the country the great bulk, however, being retained for home consumption.

It will be obvious from the import particulars which we have mentioned that Egyptian industry covers a very fair field and includes tanning, textile manufacture, soap, and many other branches. The largest single-industry import is, perhaps, that of dyes, which, including synthetic indigo, totalled £E150,687, or, at par, a rather larger amount in sterling, since the £E has a par value slightly in excess of that of the £ sterling.

SECTION IV.—AMERICA

CHAPTER XXI

CANADA

§ 1.

CANADA, of all the countries in the Empire, seems to be, at the time of writing, the most promising from a chemical point of view. As will have appeared in the course of our section concerning the United Kingdom, the resources of the Mother Country are more or less completely known and developed, and, so far as can be judged from our present knowledge, it seems possible that development in the home chemical industry is likely to be along the lines of new and more efficient processes of manufacture, rather than of the increase of existing plant and of the resources now worked.

The position in Canada, however, is very different, and, looking over a period of years, the trade may be said to be in a state of continuous expansion, with continuous progress towards self-support.

§ 2.

It is, of course, impossible to deal with an industry as a whole except in terms of money value, and, although this is misleading in so far as the years after 1914-15 are concerned, it may be useful in the first place, to consider certain general figures relating to the chemical trade of Canada, and the following table shows the increase in value of the imports and exports of chemicals and allied products, and the change in the direction of the trade quinquennially during the thirty years to 1921.

NOTE.—The statistics are mainly published for the fiscal year to March 31, and unless stated as for the calendar year, the statistics here given will be for the year to which they chiefly apply—*i.e.*, the year 1921, unless otherwise stated, is the twelve months April 1, 1921, to March 31, 1922.

It should also be borne in mind that the Canadian ton and hundredweight are 2,000 and 100 pounds respectively.

CHEMICAL AND ALLIED PRODUCTS (DOLLARS).

IMPORTS.

Year.		*United Kingdom.*	*United States.*	*Other Countries.*	*Total.*
1891	..	1,489,414	1,586,926	822,587	3,898,927
1896	..	1,204,844	1,851,534	745,742	3,802,120
1901	..	1,601,493	3,369,314	1,268,382	6,239,189
1905	..	2,395,465	4,376,862	1,496,842	8,269,169
1911	..	3,855,728	7,927,817	2,129,168	13,912,713
1916	..	4,181,980	23,098,531	1,338,624	28,619,135
1921	..	3,237,117	18,143,315	3,249,901	24,630,333
			EXPORTS.		
1891	..	236,823	99,645	43,870	380,338
1896	..	142,119	157,797	82,750	382,666
1901	..	240,375	579,861	181,308	1,001,544
1905	..	411,925	902,430	470,445	1,784,800
1911	..	655,762	1,606,526	912,497	3,174,785
1916	..	32,743,351	15,190,789	5,070,083	53,004,223
1921	..	1,062,757	5,937,136	2,506,277	9,506,170

1905 is given, as complete statistics are not available for 1906.

It will be observed from the above table that the real expansion of Canada in this industry has occurred in the last twenty years, and as the state of the chemical trade is normally considered a good indication of the state of trade generally, the comparison of the total figures year by year shows how great has been Canada's industrial progress over the period in question.

It will also be noted that as suppliers of Canada's needs the United States had a small lead over the United Kingdom in 1891, with other countries a long way behind. In the course of one decade the United States entry was more than doubled, and other countries had increased by more than 50 per cent., but the United Kingdom increase only amounted to less than one-sixth. This trend is maintained year by year until, in 1921, the imports from other countries amount to actually more than the United Kingdom quota, while America's share is between five and six times as great as that of the Mother Country. While it is certainly true that expanding local manufactures have helped to bring about this disastrous state of affairs, it is obvious that increasing competition from America is the root of the trouble, and one cannot but hope that some measures may be possible to secure for the United Kingdom a larger proportion of the Canadian trade.

§ 3.

The policy of the Canadian Government is to encourage by every means in its power, including heavy tariffs, the development of local resources and manufactures, while, as far as can be gathered, the mentality of the Canadian people is strongly in favour of the establishment of local industries as soon as there is sufficient home demand to support them.

In this connection the Canadian Government seems to have realized to the full a point that has been forcibly brought to our notice in the writing of this book—namely, that good and accessible statistics are of the utmost value in furthering the trade of the country. We have previously touched on the general lack of full and concise information available regarding the chemical industry, but Canada may be cited as an exception to the general state of affairs.

The Department of Trade and Commerce in the Dominion Bureau of Statistics at Ottawa publishes well-set-out trade statistics, which are arranged under fairly satisfactory classifications from the chemical point of view, while the Mining, Metallurgical, and Chemical branch publishes reports on the chemical industry with special tables of statistics, which give a great deal of valuable information. Moreover, all these Government publications are sold at very low prices, or even provided free to enquirers, which obviously assists the general dissemination of industrial information.

These special publications have only been produced in recent years, two of the most useful being *Chemicals and Allied Products in Canada* for 1919-20 and 1921, and the *Directory of the Chemical Industries in Canada* (as of date January 1, 1921), from which we have abstracted much of the general information (especially production figures) which we give below.

§ 4.

Little information regarding the chemical industry in Canada, apart from bare statistics, is available for the years prior to the War, but a statement of the situation after the War is given in the Directory named above, and we think that the following extracts are of sufficient importance to be worth reproducing:

" Changing conditions following the War have been reflected in the chemical industries of the country much as in other industrial activities throughout the Dominion. The most noticeable falling-off of the industries with which industrial chemistry has to do has been, of course, in munitions. The efficient way in which the Imperial Munitions Board built up and maintained this group during the War has been the cause of much favourable comment. With the Armistice, however, the need for their products collapsed, the various plants were closed, and in many cases were immediately dismantled and sold. Raw materials stocked by these concerns were thrown on the market, and for a time the glut thus produced caused established and permanent industries much concern. That period, though trying, has come to an end, and market conditions are becoming more settled and trustworthy.

" The firms continuing to manufacture explosives are in several instances expanding their interests, and are going into the manufacture of fine chemicals on a modest scale. Medicinals are still being produced, but the prospects are somewhat uncertain in this field. The paint and varnish industry is advancing by leaps and bounds, and shows every prospect of becoming one of the most successful of Canadian developments. In wood distillation there is much room for advance, and laboratories will have plenty to do for some time. In the

manufacture of pulp and paper, waste on a considerable scale continues through lack of intelligent scientific control of processes and plants. Greater interest in the conservation of the national heritage and less improvident expenditure of resources are demanded. It is noted that where men of science gather the discussion turns more and more towards conservation and economy rather than to the vastness of our natural wealth and its free expenditure.

"The development of cheap electrical power has contributed notably to the advance of industries using electro-thermic reactions, and it is predicted that the use of the electric furnace in the manufacture of steel will be greatly increased within the next few years. During the War considerable quantities of low phosphorus pig iron were thus made, and the manufacture of aluminous and silicon carbide abrasives is now an established industry. The intense heat which it is possible to develop by electrical means is a factor the true value of which as yet can only be imagined."

This statement is in a short article by S. J. Cook, Esq., B.A., A.I.C., the chief of the chemical, etc., branch of the Bureau of Statistics, and he goes on to consider some of the war-time progress of the industry in Canada.

§ 5.

As we have seen above, the chemical exports of Canadian produced material were steadily creeping up prior to the War, but the latter naturally gave them a tremendous fillip.

The electrical power available from the rivers and falls of the country is undoubtedly the outstanding Canadian resource that has a direct bearing on chemical manufacture. This power can, it is stated, easily be produced sufficiently cheaply to permit of world competition in chemical manufacture, except when unusually high tariffs restrict the market. The following table of world resources in water power, taken from the *Canada Year Book*, 1921, may be of interest in this connection.

DEVELOPED AND AVAILABLE WATER POWER OF LEADING COUNTRIES.

		Water Power.		
Countries.	*Population.*	*Developed H.P.*	*Per 1,000 Population.*	*Available H.P. (Minimum).*
Sweden	5,814,000	1,460,000	251	4,500,000
Norway	2,700,000	1,350,000	500	5,500,000
Italy	40,000,000	1,150,000	287	3,800,000
Switzerland	4,000,000	1,070,000	267	1,400,000
France	41,500,000	1,400,000	34	4,700,000
United States	105,683,108	9,823,540	93	28,000,000
Canada	8,788,483	2,762,880	314	18,255,316

The two chief entries for chemical works of this type are Shawinigan Falls, Quebec, and the Niagara Peninsula, Ontario. Here are produced such products

as calcium carbide, acetylene, carbon black, and synthetic acetic acid, and, indeed, the largest plant in the world for the manufacture of the latter product was that erected at Shawinigan Falls during the War. Other Canadian manufactures chiefly the result of the war-time effort, are such chemicals as magnesium, picric acid, soda ash, caustic soda, ammonia, and products made in electric furnaces or by electrolysis.

§ 6.

We will now proceed to set down certain general statistics relating to the chemical industry in Canada as a whole, and it will be convenient to adopt for this purpose the headings used by the Bureau of Statistics, while it will be possible to give later on in this survey some figures relating to the production of the trades named by these headings.

It should be added that the individual money figures are not in every case correct, as where there are only one or two firms in question their financial statistics are for obvious reasons disguised, for instance, by transferring part of the particulars from another source. This is automatically set right in the totals, which may be taken as correct.

The group headings under which the general and production statistics are arranged are as follows:

Coal Tar and its Products, which includes only those plants whose chief products were obtained by the distillation of coal tar or by the manufacture of such articles as disinfectants made from coal tar and its products.

Acids, Alkalies, Salts, and Compressed Gases, which includes most industrial chemicals other than coal tar products.

Fertilizers, which, for general statistics only, includes plants whose chief manufacture is fertilizers.

Medicinal and Pharmaceutical Preparations, which apparently includes such articles as patent medicines.

Certain other industries, such as paints, inks, soap, etc., are treated as part of the chemical trade, but we have thought it well to give particulars only of those groups in which the greater part of the production consists of the articles generally accepted in England as chemicals.

§ 7.

Our first table will show the number of plants under the various headings named above, together with their geographical distribution and the value of their output in the calendar year 1921.

It will be seen from the above statistics that the chief centres of chemical activity are the provinces of Quebec and Ontario, and the only parts of the Dominion that seem to threaten their lead are Manitoba in the case of medicinal, etc., preparations, and Nova Scotia in the case of fertilizers.

DISTRIBUTION, NUMBER, AND OUTPUT OF CERTAIN CHEMICAL PLANTS IN CANADA.

Industry.	*Nova Scotia.*	*New Brunswick.*	*Quebec.*	*Ontario.*	*Manitoba.*	*Alberta.*	*British Columbia.*	*CANADA.*
Coal tar and its products:								
Number of plants ..	1	—	3	5	—	—	—	9
Value of products ($)	—	—	724,622	458,508	—	—	—	1,183,130
Acids, alkalies, salts, and gases:								
Number of plants ..	2	—	13	25	4	1	5	50
Value of products ($)	—	—	3,003,678	10,126,180	242,359	—	296,603	13,869,166
Fertilizers:								
Number of plants ..	3	2	2	7	—	—	1	15
Value of products ($)	953,824	—	—	1,001,799	—	—	—	2,677,735
Medicinal, etc., preparations:								
Number of plants ..	1	1	28	65	7	—	1	103
Value of products ($)	—	—	2,443,311	8,173,898	1,155,666	—	—	11,945,435

§ 8.

Having noted the chief areas of production in the industry, it will be interesting to observe the increase of value over prime cost of raw materials under the various headings for the same period. These particulars are as follows:

MATERIALS USED, PRODUCTS MADE, AND VALUE ADDED BY MANUFACTURING (DOLLARS).

Industry.	*Total Cost of Materials.*	*Total Value of Products.*	*Value added by Manufacturing.*
Coal tar and its products ..	456,474	1,183,130	726,656
Acids, alkalies, and gases ..	5,336,568	13,869,166	8,532,598
Fertilizers	1,696,205	2,677,735	981,530
Medicinal, etc., preparations ..	4,466,001	11,945,435	7,479,434

These figures show the acid, etc., group as the largest producer, which is natural enough, but it is a little surprising that the pharmaceutical group should run it so close. It may be added that the latter class of manufactures gave employment to a greater number of people in the year under review, the figure being a total of 2,230 employees against 1,814 in the acid group, although the total of salaries and wages paid, at 2,529,898 dollars, is considerably less than that of the other group, which amounted to 3,004,948 dollars. This fact, again, indicates that patent medicines figure largely in the pharmaceutical group.

The total of salaries and wages paid under the various group headings we are at present considering amounted to 6,057,748 dollars, while the total number of employees was 4,432. These various branches of the chemical industry showed

a capital value for the whole of Canada of 51,778,585 dollars, and used 78,883 tons of coal, together with other fuel of a total value of 82,797 dollars.

From the foregoing particulars the reader will have been able to form a fair general idea of the present situation and magnitude of the chemical producing industries of Canada, though it must be realized that quantities of certain important articles, such as sulphate of ammonia, are produced in industries outside those we have so far reviewed, and the figures given above do not, therefore, include the particulars relating to this section of the Dominion's production.

Before passing on to statistics of the actual tonnage of certain products manufactured in Canada, it may be well for us to give a short account of the raw material resources of the country.

§ 9.

A considerable amount of survey work has been done in connection with the natural resources of Canada, but considering the vast size of the country, it may be taken for granted that there are many large areas of which but little is known.

Salt may be considered a most important raw material, at any rate, in so far as heavy chemicals are concerned, and Canada seems to be well provided in this respect. Material of excellent quality is produced in Ontario, at Windsor, Sandwich, Clinton, etc., and it is stated that this salt is much purer than Cheshire rock salt, which makes it especially suitable for the production of caustic soda, etc. Salt is also produced commercially in Quebec, while, according to a recent report, drilling for salt is in progress in Alberta and a certain quantity has been marketed.

Coal is found in Canada in ample quantities, but, unfortunately, it is not available between Nova Scotia or New Brunswick and Alberta. The great manufacturing provinces of Quebec and Ontario are, therefore, dependent on outside supplies, the former getting coal in summer from Nova Scotia by the St. Lawrence River, and the latter being entirely supplied from the United States.

Turning to the less important raw materials, iron, lime, antimony, manganese, copper, and lead are found in New Brunswick, while in Quebec are noted the two first named of these, together with copper, pyrites, and magnesite. Ontario, again, has iron and copper and, in addition, lead, zinc, arsenic, pyrites, fluorspar, and rare earths.

Manitoba and Saskatchewan have been but little prospected, but in Alberta are immense deposits of sand saturated with bitumen. The beds apparently vary in thickness from 140 to 220 feet and are estimated to have a distribution of at least 1,000 square miles. Their commercial value is stated to be uncertain, but the material contains a high percentage of bitumen, and it is suggested that the latter might be used for roofing, paving, etc., and also for briquetting with the lignite which occurs in the neighbourhood. In passing, it may be remarked that this lignite, which is found in several parts of Canada, does not seem to be much used, and may yet prove a source of cheap power.

Other materials of a chemical nature available in Canada are infusorial earth, barytes, asbestos, and mica, while mineral phosphate is present in quantity,

but has not been worked for some twenty-five or thirty years, owing to the competition of the more cheaply mined product of Florida.

In concluding this short statement of the raw material resources of Canada, we think it only right to acknowledge that much of our information is culled from the several Government publications regarding the mineral resources of the country.

§ 10.

We will now proceed to take the group headings named above in rotation, and to give some account of the situation and production of each in the calendar year 1921.

Coal Tar and its Products.

It is stated that two firms operating in this business in 1920 dropped out in the year under review, but in spite of this, the capital investment in the industry increased by 16 per cent., although the total value of the production declined to 55 per cent. of the value indicated for 1920.

The average number of hands employed was somewhat lower in 1921, but the average earnings per man during the year remained about the same.

The chief products of the industry during 1921 were as follows:

Product.	*Quantity.*	*Value* ($).
Creosote oils	2,530,158 gallons	435,288
Naphthalene	1,088,826 lbs.	32,990
Pitch	41,138,000 ,,	329,340
Disinfectants	40,282 gallons	48,838

In addition to the above, the composition roofing industry produced 766,935 gallons of creosote oil and special oils, and 15,880,353 pounds of pitch, making the total production of these articles 3,297,093 gallons and 57,018,353 pounds respectively. Figures are available for the production of certain other manufactures of this industry, but as only values are given, we do not propose to quote them.

Acids, Alkalies and Salts.

It is possible to give production figures for the manufactures under this heading, which includes such chemicals as sulphuric, nitric, and hydrochloric acids, caustic soda, saltcake, and calcium carbide, etc., the latter being, of course, an outstanding example of Canada's progress in the export trade during the War period, as will be shown later in our export statistics.

The capital employed in this group increased in 1921 by more than 1½ million dollars over the preceding year, although twenty-four plants only were operated against twenty-five in 1920. The average number of employees fell by about 50 per cent., but the production record did not decline to anything like the same extent.

The chief production statistics are as follows:

PRODUCTION OF ACIDS, ALKALIES, AND SALTS IN CANADA IN 1921.

Product.	*Quantity* (*Lbs.*).	*Value* ($).
Hydrochloric acid (20° Bé.)	5,116,449	93,836
Nitric acid (100 per cent.)	716,456	89,227
	(*Tons*).	
Sulphuric acid (66° Bé.)	47,195	990,101
Calcium carbide	70,794	4,728,465
Calcium cyanamide	25,291	1,486,753
Glauber's salt	1,239	42,719
Salt cake	1,919	47,516
Other sodium and potassium compounds ..	—	1,842,481
All other products	—	2,546,170
Total	—	11,867,268

In addition to the above particulars, it is noted that the explosives industry produced, for use in its own manufactures, certain quantities of materials which should be included in the acid, etc., group.

The quantities given of these for the year under review are as follows:

PRODUCTION OF ACIDS, ETC., IN THE EXPLOSIVES INDUSTRY IN CANADA IN 1921.

Product.	*Quantity* (*Lbs.*).	*Value* ($).
Nitric acids	4,043,543	338,688
Recovered acids	15,084,520	290,231
Nitroglycerine	5,955,189	1,291,726

It will be noticed that in the first table nitric acid is mentioned as 100 per cent., while no figure of purity is stated in the additional quantity. It is, therefore, impossible to arrive exactly at the total production of this acid, but it is interesting to observe that the figure given above shows an increase of, in round figures, 182,000 pounds over the production in the preceding year.

The explosives industry is also noted as producing other products and by-products for sale to the value of 229,496 dollars, and this includes unspecified quantities of sodium sulphate, nitre cake, fertilizers, superphosphate of lime, etc.

FERTILIZERS.

The position of this industry in 1921 seems to have been unsatisfactory. Depression was very general, and the value of the total output of the industry dropped by approximately one-third over the previous year, the decrease in the average number of hands being in like proportion, although the salaries and wages bill only fell about 15 per cent.

The production table for the industry itself is as follows:

PRODUCTION OF THE FERTILIZER INDUSTRY IN CANADA IN 1921.

Product.	*Quantity (Lbs.).*	*Value ($).*
Complete fertilizers	81,156,002	2,161,087
Superphosphate	6,377,280	113,992
Bone flour and meal	748,036	16,557
Meat and fish scraps and fish guano	586,000	19,340

Includes superphosphate milled in Canada.

In addition to the above weights was produced a small quantity of bone and blood, tankage, etc., but note must also be taken of the fertilizer production in other industries, of which the chief items of interest are the following:

PRODUCTION OF FERTILIZERS AND FERTILIZER MATERIALS IN OTHER INDUSTRIES IN CANADA IN 1921.

Industry.	*Product.*	*Quantity (Tons).*	*Value ($).*
Cyanamide	Calcium cyanamide	25,291	1,486,753
Slaughtering and meat packing	Animal tankage	14,131	369,975
,, ,,	Bone, raw, ground	2,784	104,377
,, ,,	Complete fertilizers	6,322	238,768
Fisheries	Fish fertilizer	—	66,077
Chemical	Mixed fertilizer	1,291	74,654
Coke and gas	Ammonium sulphate	17,340	1,183,776

MEDICINAL AND PHARMACEUTICAL PREPARATIONS.

This group can, of course, only be dealt with in terms of value, and the total production declined from 1920 by almost 4 million dollars, to a total of 11,945,435 dollars. It will be seen that this industry is of importance from the national point of view, but patent medicines form the largest item in the total, the most important for the purpose of this book being pharmaceutical preparations, which were valued at 3,917,316 dollars.

The average number of employees fell by 21 per cent. in 1920, but the capital employed in the industry increased considerably, and it is stated that great efforts are being made to fill completely the home requirements in this branch of the chemical industry and even to develop an export trade.

OTHER PRODUCTS.

Certain other production figures are of interest without giving full details of the trades concerned. The soap industry is noted as producing 1,175,742 pounds of lye, a considerable increase over 1920, and 3,023,023 pounds of refined glycerine, while the toilet preparations industry produced pharmaceutical preparations, drugs, and chemicals to a value of about 30,000 dollars. The

production of acetic acid 28 per cent. is given as 902,705 pounds, while 181,565 pounds of the 80 per cent. material were made, together with formaldehyde to a total of 1,426,399 pounds.

With these figures we think we may conclude our section relating to the chemical producing resources of Canada, and we will now consider briefly the channels of trade.

§ 11.

There are, of course, merchant houses of considerable importance in Canada, and the broker also exists. From the information we have been able to obtain, however, we think it is safe to state that the general tendency is in the direction of trade between the producer and the consumer without the intervention of third parties.

The merchant will almost certainly continue to exist in the Canadian chemical trade as in that of other countries, insomuch as he performs several useful functions, but our Canadian informants state that there is a strong tendency on the part of the consumer to put himself in direct touch with the producer, while the latter is ready to do all in his power to further this state of affairs.

The producer tends, on the whole, to look after his export sales for himself, but the import trade from the United Kingdom, etc., is largely in the hands of non-consumers, although we believe that much of the import from the American chemical manufacturers is handled direct.

As we have noted previously, chemicals enter so much into almost every manufacturing process that it is impossible to name more than a few of the most important trades causing the demand for any class of chemicals. It will, however, be possible in the case of Canada to give some idea of the number of works in some of the chief consuming industries, but it should be noted that the latest statistics of this type to which we have been able to obtain access are for the year 1919.

We may now consider the external trade of Canada, employing as far as possible the groupings under which we have dealt with the United Kingdom and other countries, in order to keep these particulars in line with the general arrangement of this book.

§ 12.

We find that the Canadian returns place all the acids together, and we will, therefore, deal with the inorganic and organic acids in one table for convenience rather than consider them in their appropriate groups. In the returns we find Canada noted as an exporter of acetic and sulphuric acids, the figures being as follows:

EXPORTS OF CANADIAN-MADE ACIDS.

Acetic acid	326,800 lbs.
Sulphuric acid	6,292,100 ,,

The acetic acid went to the United Kingdom chiefly, and the sulphuric acid to the United States. No itemized figures are given for 1913, but the total acid

export was 6,245,100 pounds against a total of 6,456,700 pounds for 1921, and the amount taken by the Empire is small in 1921, and nil in the pre-war year.

Turning to the question of imports, the acids worthy of mention are those named above, together with nitric, tartaric, and oxalic acids. The following table gives comparative particulars of the imports of these five acids, together with the total import of acids noted in the years with which we are dealing. It is obvious that the totals can only be given as values.

IMPORTS OF ACIDS INTO CANADA.

Product.	*Source.*	1913. (*Lbs.*).	1921. (*Lbs.*).
Acetic acid	Empire	46,008	6,574
	Foreign countries	196,276	26,567
	Total	242,284	33,141
Nitric acid	Empire	8,480	Nil
	Foreign countries	254,196	71,643
	Total	262,676	71,643
Oxalic acid	Empire	41,509	17,992
	Foreign countries	252,343	250,495
	Total	293,852	268,487
Sulphuric acid	Empire	Nil	Nil
	Foreign countries	159,857	184,411
	Total	159,857	184,411
Tartaric acid	Empire	68,721	36,188
	Foreign countries	261,945	314,517
	Total	330,666	350,705
		($).	($).
All acids	Empire	102,763	96,697
	Foreign countries	257,021	396,404
	Total	359,784	493,101

GENERAL HEAVY CHEMICALS.

Nitric and sulphuric acids having been dealt with in the preceding table, we will now turn our attention to the chemicals soda, etc., arsenic, calcium carbide, acetate of lime, white lead.

Other chemicals are, of course, exported, but it is not possible in a book of this size to do more than touch upon the most important products in the chemical world.

Of the chemicals named above, calcium carbide and acetate of lime are, we believe, the most worthy of note, and the statistics relating to these are as follows:

EXPORTS OF CANADIAN PRODUCED CALCIUM CARBIDE AND ACETATE (CWTS.).

Product.	*Destination.*	1913.	1921.
Calcium carbide	Empire	46,799	17,599
	Foreign countries	7,612	496,051
	Total	54,411	513,650
Calcium acetate	Empire	60,059	Nil
	Foreign countries	87,037	22,109
	Total	147,096	22,109

As regards the other chemical exports mentioned above, it will suffice to say that the heading of soda and sodium compounds was not shown separately in 1913, but in 1921 a quantity of 19,677,600 pounds was exported, of a value of 1,491,018 dollars, the chief customers being the United States and Mexico.

In the case of arsenic, the statistics are not quite clear, but it would seem that the total export in 1913 was 2,948,700 pounds, against, in 1921, 2,326,900 pounds, the only customer in these two years being the United States.

White lead, dry or in oil, is only shown for 1921, and the total export in that year was 946,500 pounds, the Empire, and especially the United Kingdom, accounting for by far the greater part of this total.

The alkali group of chemicals forms the largest part of that section of the import trade with which this book is concerned, and it will again only be possible to deal with a selection from the many headings noted in the official statistics.

Taking in the first place the headings under sodium and sodium compounds, we find the following total comparison:

TOTAL IMPORTS IN SODIUM CLASS INTO CANADA.

Source.	1913.		1921.	
	Lbs.	$.	*Lbs.*	$.
Empire	60,288,412	524,308	3,813,275	167,184
Foreign countries	84,790,443	976,702	30,783,839	2,645,171
Total	145,078,855	1,501,010	134,597,114	2,812,355

NOTE.—Nitrate of soda is not included in the above, but is treated as a fertilizer.

It will be as well to deal more fully with certain articles in this class, and we will first consider soda ash and saltcake. In the case of the former, the total quantity imported in 1921 was little more than 10 per cent. of that in 1913, while the chief source of supply changed, as in the case of so many chemicals during the War, from the United Kingdom to the United States. In the case of the latter,

the quantity more than doubled over the period in question, and the United Kingdom lost its trade to the same competitor.

The detailed figures for these two products are as follows:

IMPORTS OF SODA ASH AND SALTCAKE INTO CANADA (LBS.).

Product.	*Source.*	1913.	1921.
Soda ash	Empire	35,291,417	689,740
	Foreign countries	28,336,343	6,122,110
	Total	63,627,760	6,811,850
Saltcake	Empire	7,799,020	10,056
	Foreign countries	20,117,731	58,837,971
	Total	27,916,751	58,848,027

We will now consider caustic soda and sodium silicate. The quantities of the former entered in the two years under review kept very level, and some trade is also done in packets of under 25 pounds, the amount in 1913 being 185,407 pounds, and in 1921, 126,389 pounds. This small trade is included in the statistics given below, and it will be seen also that in this material again the United Kingdom has lost its place.

In the case of sodium silicate the total quantity imported has increased by more than 50 per cent. and this trade has been largely in the hands of America in both years. The detailed table for these two products is as follows:

IMPORTS OF CAUSTIC SODA AND SODIUM SILICATE INTO CANADA (LBS.).

Product.	*Source.*	1913.	1921.
Caustic soda	Empire	4,401,327	992,966
	Foreign countries	10,158,759	13,070,942
	Total	14,560,086	14,063,908
Sodium silicate	Empire	873,629	577,216
	Foreign countries	12,998,417	21,486,946
	Total	13,872,046	22,064,162

The only other sodium heading upon which we propose to touch is "hyposulphite." This chemical is relatively a small trade, but the figures show the quantities imported for tanneries and also for other purposes, and for this reason we think them worthy of note.

In 1913 Canada imported 378,430 pounds of this product, valued at 4,491 dollars, for tanning purposes, and quantities to the value of 7,974 dollars for other purposes. The corresponding figures for 1921 are: 414,052 pounds valued at 14,703 dollars, and 24,593 dollars. The United States was the chief supplier in both years.

Turning now to the potassium group of imports, it will be enough if we deal with this in the same manner as the sodium group. The total import trade is shown in the following table:

TOTAL IMPORTS IN POTASSIUM CLASS INTO CANADA.

Source.	1913.		1921.	
	Lbs.	$.	*Lbs.*	$.
Empire	955,038	74,810	387,481	96,492
Foreign countries	4,758,233	470,642	2,239,774	327,205
Total	5,713,271	545,452	2,627,255	423,697

The above figures may be taken as relating only to potashes used for manufacturing purposes, etc., as potash salts for manure are entered separately in the fertilizer class, and will be dealt with in due course.

The chief potash products imported are chlorate, nitrate, and cream of tartar. The import of the latter fell considerably during the period under review, although the export of baking powder increased and the import of the same article decreased from 737,297 to 26,903 pounds. In the case of the chlorate, which is entered as "not further prepared than ground," the total fell away considerably, and, as usual, the United Kingdom lost the greater part of its trade, while the nitrate—saltpetre—imported in 1921 was less than one-third of the imports in 1913. The United Kingdom, however, managed to obtain a greater proportion of this total than in 1913, and it is refreshing to observe that Germany's quota is nil in 1921 against 560,700 pounds in 1913. The details relating to these three products are as follows:

IMPORTS OF POTASSIUM NITRATE AND CHLORATE AND CREAM OF TARTAR INTO CANADA (LBS.).

Product.	*Source.*	1913.	1921.
Potassium nitrate	Empire	146,611	53,345
	Foreign countries	1,563,017	480,068
	Total	1,709,628	533,413
Potassium chlorate	Empire	407,665	6,884
	Foreign countries	765,036	435,971
	Total	1,172,701	442,855
Cream of tartar	Empire	70,159	189,611
	Foreign countries	1,513,720	668,493
	Total	1,583,879	858,104

Other potashes of which the import is worthy of note are:

Potash and pearlash; bicarbonate; bichromate; caustic; red and yellow prussiates.

It is scarcely worth while giving detailed particulars of these products, but the following table will give the total of the quantities and values shown under these headings in the years under review:

TABLE OF THE POTASHES NAMED ABOVE IMPORTED INTO CANADA.

Source.	1913.		1921.	
	Quantity (*Lbs.*).	*Value* ($).	*Quantity* (*Lbs.*).	*Value* ($).
Empire	330,603	24,400	76,059	10,247
Foreign countries	916,460	53,777	362,153	37,238
Total	1,247,063	78,177	438,212	47,485

We have now dealt with the chief chemical imports of Canada, but there remains a certain number of products which are sufficiently important to command our attention. We will in the first place consider alums, which were entered differently in 1913 from the headings in 1921; we have, however, in the following table endeavoured to give a true comparison between the two years in addition to showing as much detail as possible.

IMPORTS OF ALUMS INTO CANADA (LBS.).

Customs Heading.	*Source.*	1913.	1921.
Alum in bulk, ground or unground, but not calcined	Empire	—	757,629
	Foreign countries ..	—	5,067,499
	Total	—	5,825,128
Sulphate of alumina or alum cake ..	Empire	—	385,677
	Foreign countries ..	—	16,047,073
	Total	—	16,432,750
Alum in bulk, ground or unground, but not calcined, and sulphate of alumina or alum cake	Empire	5,078,286	1,143,306
	Foreign countries ..	15,588,928	21,114,572
	Total	21,667,214	22,257,878

It will be seen from the above that some part, at least, of Canada's supplies of alums is still drawn from the Empire, but we must now touch upon two articles in the supply of which the Empire has very little share—namely, nitrate of ammonia and liquid chlorine.

In the case of the latter, no statistics are noted for 1913, but in the later year 3,958,427 pounds to the value of 248,987 dollars were imported from America. As regards nitrate of ammonia, the Empire contributed only 114,545 pounds (all from the United Kingdom) to the 1913 total import of 2,572,044 pounds, while in 1921 the total quantity of 2,017,078 pounds came from foreign sources.

We now turn to sal ammoniac and copper sulphate. In the case of the former, the Empire supply (from the United Kingdom in both years) was larger in 1921

than in 1913, to the detriment of Germany, whose share fell from 297,069 pounds before the War to a mere 4,815 pounds in 1921. The position in copper sulphate is not quite so satisfactory, but the United Kingdom has, at any rate, retained a good proportion of its pre-war business. The full statistics for these two products are as follows:

IMPORTS OF SAL AMMONIAC AND COPPER SULPHATE INTO CANADA (LBS.).

Product.	*Source.*	1913.	1921.
Sal ammoniac	Empire	378,767	458,331
	Foreign countries	406,005	441,161
	Total	784,772	899,492
Copper sulphate	Empire	791,477	678,998
	Foreign countries	543,768	833,740
	Total	1,335,245	1,512,738

The only further articles upon which space allows us to comment are: red and orange lead, white lead and glycerine.

The total quantities of red and orange lead imported in 1913 and 1921 were respectively 2,296,435 and 822,914 pounds, the Empire, which for this purpose is the United Kingdom, supplying 1,457,446 and 251,003 pounds, while in the case of white lead, both dry and ground in oil, it is refreshing to see that the United Kingdom has actually increased its proportion of the trade in comparison with 1913. The total in 1913 was 1,894,566 pounds, of which England supplied 1,488,032 pounds, and in 1921 the United Kingdom sent in 93,750 pounds out of a total of 113,933 pounds, America being the loser in both cases.

The figures relating to the item glycerine are as follows:

IMPORTS OF GLYCERINE INTO CANADA (LBS.).

Source.	1913.	1921.
Empire	3,712,738	52
Foreign countries	2,116,181	2,541,422
Total	5,828,919	2,541,474

It will be observed from this table that, as in the case of almost all the products noted, the War has changed the main sources of supply, to the advantage of the United States.

§ 13.

COAL TAR PRODUCTS.

As we have seen above, Canada has a flourishing coal tar industry of its own, and it is unnecessary to deal here at any great length with the external section of this trade. Exports are noted of 984,824 gallons of creosote oil in 1913, the corre-

sponding total for 1921 being 397,402 gallons, and the only buyer of importance in both years was the United States; also of coal tar and pitch in 1921 to the amount of 2,307,528 gallons (*sic*), the chief bulk of which was sent to France, Belgium, and the United States.

Turning to the import market, the only headings we have been able to trace refer to coal tar and pitch, carbolic or heavy oil, and refined naphthalene. In the case of the first, 1913 is not noted, but for the four years 1918 to 1921, the United States supplied practically all the material imported. We are not certain what products are covered by the second heading, but out of a total of 1,022,197 gallons in 1913, the United Kingdom supplied 329,639 gallons, the balance coming chiefly from America; the corresponding figures for 1921 are 547,814 and 201,373 gallons respectively, and the position of the United Kingdom is, therefore, relatively better.

As regards refined naphthalene, statistics are only available for the years 1919 to 1921, but in each of these years the proportion of trade is greatly in the favour of the United Kingdom, which divides the total with the United States. The figures for 1921 show that 428,694 pounds came from the United Kingdom against 30,257 pounds from the United States, the total import being 458,951 pounds.

We think it may be safely taken that, in spite of Canada's war progress in the coal tar industry, she is likely to be for some time to come a buyer of coal tar products.

§ 14.

Dyestuffs and Intermediates.

No exports of coal tar intermediates or dyestuffs are noted, and Canada can scarcely be considered a serious producer of these products as yet, at any rate, from the Empire point of view; the total production of dyes and dye soaps is given as only 416,743 dollars in 1921.

In the import returns, however, we find headings for certain articles, the intermediates noted being crude aniline oil, aniline salt, and paranitraniline. The following table gives the total import of these articles:

Imports of Coal Tar Intermediates into Canada (Lbs.).

Source.	1913.	1921.
Empire	185,854	4,462
Foreign countries	84,411	268,623
Total	270,265	273,085

Turning now to the dyestuffs themselves, a certain amount of trade is noted in packets under 1 pound each, but we may safely neglect this. The bulk trade in water-soluble colours and synthetic indigo is shown in the following table:

IMPORTS OF WATER-SOLUBLE COAL TAR DYES AND INDIGO PASTE AND EXTRACT INTO CANADA (LBS.).

Product.	*Source.*	1913.	1921.
Dyes	Empire	191,566	307,686
	Foreign countries	2,048,729	1,657,906
	Total	2,240,295	1,965,592
Indigo paste and extract	Empire	1,265	6,708
	Foreign countries	146,469	45,472
	Total	147,734	52,180

It will be observed from the above tables that the bulk of Canada's supplies in this group is drawn from foreign countries, and, as a matter of fact, America has now gained a long lead in this connection.

§ 15.

FERTILIZERS.

Canada is primarily an exporting country in so far as fertilizers are concerned. The total value of imports under this heading in 1913 was 2,507,618 dollars (Empire, 75,680 dollars), and in 1921, 1,887,384 dollars (Empire, 40,964 dollars), while the corresponding figures for exports are: 1913, 2,539,789 dollars (Empire, 93,583 dollars), and 1921, 2,213,351 dollars (Empire, 200,112 dollars).

The chief fertilizers exported are sulphate of ammonia and cyanamide, though a fair quantity of tankage, etc., is despatched to the United States. We give below the exports of the two first-named manures for 1921, but it is not possible to give comparative statistics for 1913, as manufactured fertilizers were only entered under one heading by values in that year.

EXPORTS OF CANADIAN PRODUCED SULPHATE OF AMMONIA AND CYANAMIDE IN 1921 (CWTS.).

Product.	*Destination.*	*Quantity.*
Sulphate of ammonia	Empire	75,265
	Foreign countries	262,801
	Total	338,066
Cyanamide	Empire	Nil
	Foreign countries	357,695
	Total	357,695

A small quantity of phosphate rock was also exported in 1913, but the Canadian product cannot now compete with Florida rock.

Turning now to the imports, the chief of these are naturally enough nitrate of soda and potash salts, the greater part of the latter being muriate in the crude. The following table shows the details under these headings:

IMPORTS OF CERTAIN FERTILIZERS INTO CANADA (LBS).

Product.	*Source.*	1913.	1921.
Nitrate of soda	Empire	480,966	5,877
	Foreign countries	79,781,215	22,832,331
	Total	80,262,181	22,838,208
Potash fertilizer salts	Empire	546,498	558,670
	Foreign countries	15,188,182	8,133,684
	Total	15,734,680	8,692,354

The bulk of the nitrate of soda was, of course, from Chile in 1913, but the United States supplied the whole foreign share in 1921. The United States had a lead in the supply of potash in 1913, with Germany taking second place; the position was reversed, however, in 1921.

Other fertilizers imported are sulphate of ammonia, superphosphate, etc., but the quantities are relatively inconsiderable, and we do not think it necessary to give further particulars in this connection.

§ 16.

FINE CHEMICALS, DRUGS, AND MEDICINAL CHEMICALS.

There is no great amount of information available regarding the chemicals in these two classes, and we have, therefore, thought it well to treat them together. We can find no named exports of any of the articles we have grouped under these headings, but the total value of exports noted under the classification "Drugs, Medicinal—Medicinal and Proprietary Preparations," is in 1921, 497,595 dollars, while the total import figures under the classification "Drugs, Medicinal, and Pharmaceutical Preparations" are given both for 1913 and 1921, and are respectively 1,642,476 and 2,444,333 dollars, the Empire contributing in the earlier year 569,377 and in the later year 796,225 dollars.

Some drugs are entered by value, but the quantities of the most important are shown in the table on p. 160.

Other materials mentioned by name in this class are caffeine, codeine, strychnine, etc., and it may be added that the total value figure (imports) given above includes medicinal wines and similar articles.

§ 17.

Canada certainly carries out a little re-export trade in chemicals, but the total value is so small relatively to the exports of Canadian produced material that we have not considered it necessary to make use of the figures which are noted in the returns.

IMPORTS OF CERTAIN DRUGS INTO CANADA.

Product.	*Source.*	1913 (*Lbs.*).	1921 (*Lbs.*)
Opium, crude and powdered	Empire	1,755	1,441
	Foreign countries	2,968	400
	Total	4,723	1,841
		(*Ounces*).	(*Ounces*).
Salts of quinine	Empire	25,053	11,622
	Foreign countries	105,184	95,884
	Total	130,237	107,506
Cocaine	Empire	75	893
	Foreign countries	953	2,059
	Total	1,028	2,952
Morphia	Empire	4,280	8,194
	Foreign countries	207	580
	Total	4,487	8,774

§ 18.

In concluding this survey of the chemical resources and trade of Canada, it only remains for us to give some particulars regarding the chief trades causing the demand for the chemicals we have enumerated.

It is, of course, impossible to treat this question in any detail, but we note, for example, twenty-two baking powder works, etc., in 1919, which would doubtless consume tartaric acid and cream of tartar. In the same year are listed several hundred probable consumers of chemicals used in textile manufacture; five dyeing and finishing works; about 200 possible users in the paper trade, which would account for much of the saltcake, alums, and soda ash imported; twenty-six soap manufacturers who needed supplies of caustic soda, etc. It would be possible to give many more particulars of this sort, but we do not think they would be very interesting or valuable.

The position may be summed up by saying that Canadian industry, as a whole, covers almost every sphere of manufacture, and there is scarcely any manufacturing trade which does not depend in greater or less degree upon chemicals.

CHAPTER XXII

NEWFOUNDLAND AND LABRADOR

LABRADOR is partly included in Newfoundland and partly in Canada, and it may, therefore, be mentioned here. Its chief interests, however, are fishing and trapping, so the Colony scarcely requires any separate consideration in this book.

Turning now to Newfoundland itself; the chief industries are fishing, mining, and lumbering, and the paper-pulping section of the latter may be taken as the chief interest from a chemical point of view, though the fisheries probably account for a quantity of salt.

The chief mineral resources for consideration here are copper, pyrites, lead, and coal, while considerable water power is, of course, available.

The statistics available are not particularly informative, articles being entered largely by values, and only a few headings noted. The only weight given is salt in bulk, of which 52,321 tons were brought in for 1913, and 50,621 tons for 1921, Spain being the chief supplier in both years. Other listed headings do not show much value apart from tar, at 17,135 dollars and 22,714 dollars, and here the United States and Canada hold the bulk of the trade.

It should be added, however, that the greater part of the imports are shown as values (materials not specified) for use in the manufactures of the company importing, and this system doubtless covers up the bulk of the chemicals bought by the Colony.

The export statistics are not illuminating, a little whale fertilizer going to the United States, etc., in 1913 and some salt to St. Pierre (which is practically a dependency, although owned by France) in the later year.

CHAPTER XXIII

BRITISH HONDURAS. BERMUDA. THE BAHAMAS. JAMAICA AND DEPENDENCIES

BRITISH HONDURAS, BERMUDA, AND THE BAHAMAS

IT will be convenient to deal with these three areas under the one heading, as the statistical information available is very small.

British Honduras has apparently not been very fully prospected, but it seems not improbable that various mineral resources may eventually be discovered. In the meantime, however, it would appear that any chemical trade of importance is a matter for the future, as the present imports are negligible, salt and medicines being the chief items.

Bermuda, or more properly the Bermudas, need only be touched on quite briefly here. The chief industry is agriculture, but the soil is poor and needs

considerable quantities of fertilizers, the amount imported in 1913 being 17,793 packages, to a total value of £7,264. The corresponding total for 1921 is 16,709 packages, valued at £10,194, and chemical supplies come chiefly from the United States, though in the case of fertilizers the United Kingdom had a larger share in 1921.

The Bahamas are growers of pineapples and sisal as well as other agricultural produce, and naturally enough fertilizers are to some extent used, the quantity for 1913 being 1,291 barrels, valued at £1,067, and for the later year 1,189 barrels (£1,222). The United States chiefly supply such chemicals as are imported, but no other entries are worth mentioning here. Salt is the only local production in this section, 35,263 bushels, valued at £367, being exported to Jamaica in 1913. The total export for 1921 was considerably larger at 126,058 bushels, and the value was £3,003, while the two figures named, converted to weight, give about 880 and 3,150 tons respectively.

JAMAICA AND DEPENDENCIES

The dependencies of Jamaica consist of the Cayman Islands, the Turks and Caicos Islands, Pedro Cay and Morant Cay, and all these islands may conveniently be dealt with under the one heading.

Jamaica itself is largely given over to the growing of sugar and other plantation products. As may be expected, therefore, the chief item in the imports list is chemical manure, of which the value for 1913 amounted to £6,530; the value was not much greater in 1921 (at £7,599), but the quantity is given for this year as 433 tons, the chief source of supply being the United Kingdom. Other named items are quite unimportant, with the exception of salt, of which 10,311,972 pounds, valued at £10,312, were brought in from the United Kingdom, the Bahamas, etc., in 1913, the corresponding quantity for 1921 being 13,761,025 pounds (£48,164). The main sources were much the same as in the pre-war year.

Exports of bones and horns and sarsaparilla are noted as local produce, but there is no other export trade worth mentioning.

Turning now to the dependencies of Jamaica, Pedro and Morant Cays are both guano islands, but we can trace no statistics relating to them, while phosphate deposits constitute the claim to mention here of the Cayman Islands; they do not, however, appear to be worked now, and no statistics can be traced.

We may conclude this section by saying that the Turks and Caicos Islands are only of importance as producers of salt, a quantity of between 50,000 and 60,000 tons being exported to the United States, Canada, etc., in 1913.

CHAPTER XXIV

THE LEEWARD ISLANDS. THE WINDWARD ISLANDS

THE LEEWARD ISLANDS

The islands included under this heading are Antigua, Barbuda, Redonda, Anguilla, Dominica, St. Kitts, Nevis, Montserrat, the Virgin Islands, and Sombrero.

The statistics of importance are published for the group as a whole, and it will be convenient to give some small description of the chief islands by name, and then to consider such statistical information as is relevant for the group's total external trade.

Antigua itself is unimportant from our point of view, except, perhaps, as a consumer of fertilizers, its chief productions being sugar and cotton. The dependencies of Barbuda and Redonda, however, are of interest, the former as a producer of salt and phosphate of lime and the latter for its production of aluminium phosphate. No exact statistics are available as to production, though this is fairly considerable, but according to the Blue Books eighty to ninety men are employed by the Redonda Phosphate Company, the United States being the chief market.

Anguilla is of interest to this volume only as a producer of salt, and to some extent a grower of cotton, while Dominica exports citrate of lime (total production of the group for 1921, 6,537 hundredweights), and grows cocoa, coconuts, and fruit. Water power is also available.

Montserrat is not to any extent a grower of sugar, but lime-juice and cotton are exported, and also papain; while St. Kitts and Nevis are producers of sugar and cotton, and coconuts are cultivated in the latter island. It should be added that the islands as a whole appear to be of volcanic origin, and it would therefore seem that sulphur may one day be discovered in payable quantities.

The statistical detail given is very small, and the total chemical trade of the group is unimportant. The largest imports are chemical manures (£10,030 in 1913 and £26,700 in 1920) and "Chemicals" (£2,836 and £10,456). The Empire is the chief supplier, while the only locally produced export noted is salt, of which 7,017 barrels were sent out in 1913 and 864 tons in 1920. The last statistics available refer to 1920, and are stated to be incomplete.

THE WINDWARD ISLANDS

The Windward Islands consist of St. Lucia, St. Vincent, the Grenadines, and Grenada. Their chemical trade is very small, but we will give some indications of possible outlets as in the case of the Leeward Islands.

St. Lucia has only increased very gradually in population since it was finally gained by Great Britain in 1803, but it would appear that its demands may expand at a greater rate now than was the case in the earlier years of this century. The

local industry is of the agricultural order, sugar, cocoa, limes, etc., being produced, while several sugar factories are in existence.

St. Vincent is also a grower of sugar and cocoa, and to some extent cotton, some water power being available, while Grenada grows cocoa, rubber, and other plantation products, and Carriacou, the largest of the Grenadines, cotton and limes.

The only article common to the whole group in the returns for both years is coarse salt, of which the 1913 total import was 680 tons, the corresponding post-war figure being 1,360 tons; the import of this material is entire
ing islands.

Other headings are shown, but, as is to be expected, the or
mentioning are of the fertilizer class. Here the total bought l
was 792 tons and in 1921, 214 tons. No figures are given fo
St. Lucia took in the later year 1,500 tons of manure, of which :
of nitrate of soda.

The export details of all three islands are insignificant, but i
to mention that Grenada exported a little salt in 1921, St. L
sulphur and St. Vincent a few hundredweights of Glauber s
in each case being Barbados and the produce of local origin.

CHAPTER XXV

BARBADOS. TRINIDAD AND TOBAGO. BRITISH GUIANA. THE FALKLAND ISLANDS

BARBADOS

THE chief production of Barbados is sugar, though a certain amount of cotton is also exported. The only natural resource noted in so far as chemical products are concerned is asphalt, which exists and is to some extent worked and exported.

A fair amount of statistical information is available, and, as is to be expected, fertilizers figure largely in the import returns, the chief articles of interest being shown in the following table:

IMPORTS OF CERTAIN FERTILIZERS INTO BARBADOS (TONS).

Product.	1913.		1921.	
	Quantity.	*Chief Source.*	*Quantity.*	*Chief Source.*
Sulphate of ammonia ..	3,999	Canada	3,098	United Kingdom
Nitrate of soda	388	United Kingdom	445	Chile
Other manures not "raw"	2,805	United Kingdom	2,953	Canada

A small quantity of dried blood is also noted for 1913, while the other named imports, apart from salt, are not worth detailing, although it would seem clear that the Colony was a larger buyer in 1921 than in 1913. Salt other than table

salt accounts for 2,318 tons, chiefly from the United Kingdom, in the earlier year and 1,995 tons in the later, but the chief suppliers after the War were the Turks and Caicos Islands and the French West Indies.

A little re-export is carried on with islands in the vicinity, but apart from the asphalt mentioned above no export of any magnitude is noted as local produce.

TRINIDAD AND TOBAGO

These two islands, which are treated as one for statistical purposes, export a considerable amount of cocoa, sugar, and other agricultural products, and, as is to be expected, the chief article of import is chemical manure (unspecified), the value of which came to £22,058, mainly from the United Kingdom, in 1913.

The interest of the Colony to the present volume, however, lies in the great natural deposits of asphalt in Trinidad, the chief of which is a lake of more than a hundred acres in extent.

The working of this product is in the hands of an English company, and the value of the export is quite considerable, the details being as follows:

EXPORTS OF ASPHALT FROM TRINIDAD.

Grade.	1913. Quantity (Tons).	1913. Value (£).	1921. Quantity (Tons).	1921. Value (£).
Crude	152,007	120,126	23,600	28,754
Epuré	19,421	38,841	789	2,139
Dried	34,405	69,395	67,933	204,531
Manjak	583	2,203	2	36
Total	206,416	230,565	92,324	235,460

The United Kingdom and the United States are the largest buyers, and it may be pointed out in passing that this table forms an excellent example of the extreme fallaciousness of statistics in terms of money.

We are dealing with precisely the same product, but the *wealth* involved—which is what matters—in the later year is only about four-ninths of that in the earlier year, whereas the *money* shows an increase.

BRITISH GUIANA

The chief production of this area is sugar, though other plantation and agricultural products are exported, and rubber is to some extent grown.

A certain amount of statistical information is noted, the imports running on the same lines as any of the West Indian Islands or similar colonies. The chief headings are chemical manures, of which 14,111 tons were imported in 1913, and 8,392 tons in 1921, largely from the United Kingdom in both years, and salt. The latter is imported from the West Indies in coarse or rock form, but the great bulk consists of fine salt from the United Kingdom, the amount for the pre-war

year being 1,690 tons against a decrease to 1,348 tons, after the War. A considerable import of opium preparations is also noted in 1913, but the corresponding quantity for 1920 is quite small.

Such export trade as is done consists largely of re-exports to Dutch and French Guiana and the British West Indies, but a small quantity of locally produced salt is noticed, and citrate of lime would appear to be an expanding local manufacture, as 4,068 pounds were exported in 1913, while the quantity has increased to 49,161 pounds in 1921. The United Kingdom is the outlet for this product.

THE FALKLAND ISLANDS

The industry of this group is almost entirely of a pastoral character, the chief export being wool. It may, therefore, be assumed that the imports—which, so far as this book is concerned, are grouped under the comprehensive heading of "Chemicals," and totalled, in 1913, £3,449, chiefly from the United Kingdom—are entirely articles of the order of such necessities as drugs and sheep dips, etc.

The group is also a centre of whaling activity, but we cannot trace any export of by-products from this trade. The islands, however, have large deposits of guano, and this is exported to a considerable value, the details being shown in the following table:

Export of Guano from the Falkland Islands.

	1913.			1920.	
Destination.	*Quantity (Bags).*	*Value (£).*	*Destination.*	*Quantity (Bags).*	*Value (£).*
Holland	5,968	3,000	South Africa	7,487	7,487
United Kingdom	46,082	23,921	United Kingdom	9,536	7,786
Norway	15,311	5,613	Argentine	1,556	2,000
Total	67,361	32,534	Total	18,579	17,273

Bone meal is also produced locally and exported, the quantity for 1913 being 4,897 bags, valued at £1,564, but for 1920 no export is shown. The United Kingdom was the chief buyer in 1913.

SECTION V.—AUSTRALASIA

CHAPTER XXVI

THE AUSTRALIAN COMMONWEALTH

§ 1.

AUSTRALIA is largely an agricultural and pastoral country, as is proved by the fact that, out of an estimated production of £348,183,000 in 1919-20, the total shown under the heading " Manufacturing Industries " is only £98,162,000.

Turning now to that section of industry with which we are dealing, we find the value of work turned out in the same year to be £4,625,416; the value of materials used or worked up amounted to £2,806,585, giving a production figure of £1,818,831, of which £1,257,727 is attributable to chemicals, drugs and medicines, and the balance to fertilizers.

(NOTE.—The foregoing figures and subsequent ones for 1919-20 may be to some extent inaccurate, owing to differences in the date of returns, etc., from the various States. We think, however, that they are quite adequate to give a fair general view of the situation, while as regards the further statistics which we shall give, it should be borne in mind that, owing to a change in organization, those for 1913 refer to the calendar year, whereas those noted as 1921 are for the twelve months ending June 30, 1922.)

Australia has undoubtedly made progress in the production of chemicals since 1913, but she remains a buyer rather than a producer, as is evidenced by the fact that her imports in 1921 total £3,553,377 (Class XXI., drugs, chemicals, and fertilizers), against a corresponding export total for Australian produced material of £501,326. She may, however, rank as a producer of fertilizers, and we shall deal fully with this section later. Fertilizers figure but little in the imports total given above, but are of much account in the exports.

Australia's chief industrial areas are the States of Victoria and New South Wales, and the statistics show this general distribution to hold good in the case of the chemical section also, the number of works (including paint and varnish works) being noted for 1920-21 as 131 and 126 in these two areas respectively, out of a total for the Commonwealth of 305 works in this group.

We think it may safely be stated that Australia, like the other Dominions, is actuated by a desire to produce for herself rather than import, but local demand is usually considered the basis for the establishment of a new industry, and it does not seem that Australia is yet in a position to absorb the production of any large chemical industry.

The Government, however, undoubtedly does what it can to assist Australian self-support and development, even to the extent of giving bounties in certain

The corresponding figures for 1921-22 are £346,662,000 and £120,751,000 respectively, and in the same period the production figure for chemicals, etc., was £3,304,286.

directions and using the tariff for the special encouragement of certain branches of industry, while the Statistical Department appears to be well organized and to be a source of much information which cannot fail to assist in the expansion of Australian industry.

§ 2.

In a continent the size of Australia it may be taken that large areas remain practically unprospected. Such chemical raw materials, however, as chromium, tin and antimony ores, copper, lead, magnesite, lime, and zinc, are produced commercially, while articles of more direct interest to the present volume are arsenic, barytes, salt, phosphate rock, and guano.

Taking these in order, arsenic is found in Queensland and New South Wales, while a quantity of arsenical ore was exported from Western Australia in 1920. Barytes is produced in South Australia, Tasmania, and New South Wales; and salt exists in considerable quantity in various parts of the Commonwealth, large quantities being produced from salt lakes in South Australia.

Phosphate rock is worked commercially in South Australia, Victoria, and New South Wales, some details of production being available for a later section in this chapter, while large accumulations of guano exist in the Abrolhos Islands, off the coast of Western Australia.

Finally, Australia is, of course, an important producer of coal, the estimated reserves being enormous, so that the requisite fuel for chemical manufacture is readily available and a considerable coal tar industry is quite within the bounds of possibility.

§ 3.

We have not been able to trace many detailed figures relating to the Commonwealth production of chemicals, etc., but the total value of chemicals, drugs, and medicines turned out in 1919-20 was £2,862,992, the corresponding figures for fertilizers being £1,762,424. We have given in section 1 the production values of these products—*i.e.*, the difference between cost of raw materials and value of finished products.

The only production figure given for our section in the official return is for bone dust, at 36,183 tons in 1919-20. It is stated, however, in the 1922 Year Book that the local production of fertilizers assumed large proportions in the few years prior to 1922, and we have obtained from this source a few additional details relating to production. In the year 1920, 70,871 tons of salt are shown as the produce of South Australia, with a quantity unstated coming from Victoria; while 4,081 tons of sulphate of ammonia and 2,561,718 gallons of tar were produced in 1921 by one company in Newcastle, New South Wales, 214 by-product ovens being in use. The production of barytes for 1920 apparently amounted to about 3,764 tons, while figures noted for phosphate rock in the same year amount to approximately 13,000 tons.

The corresponding production figures for 1921 are: salt, 56,492 tons; barytes, 1,470 tons; and phosphate rock, 7,189 tons; while bone dust produced in 1921-22 amounted to 25,587 tons.

§ 4.

Heavy Chemicals.

Turning now to the external trade of the Commonwealth, the export statistics, taken with particulars of re-exports, are distinctly interesting as showing the country's progress in this group. The Empire—chiefly New Zealand and the near Pacific—accounts for such a large proportion of the export trade under this heading that we do not consider it worth while to give details relating to destination, but we note instead the exports and re-exports shown for each article considered worthy of mention.

Taking in the first place the products for which 1921 figures only are available, we find relatively considerable exports of casein, anhydrous ammonia and glycerine; no weights are given for the first two products, but the total value sent out was £39,146 and £26,666 respectively. The ammonia was entirely Australian in origin, and only £770 worth of casein was re-export business. In the case of glycerine, New Zealand was the only buyer, and out of 49,194 pounds exported, only 2,240 pounds was of outside origin.

Comparative figures are available for sulphate of copper, certain acids, calcium carbide, certain sodium products, and salt. The first named was entirely a re-export in 1913, but in 1921 Australia was producing for sale, although the quantity sent out was very small. In the case of the other articles named, a little grouping will enable us to show details in the tabular form:

Exports and Re-Exports from Australia of Certain Heavy Chemicals (Cwts.).

Product.	1913.			1921.		
	Exports.	*Re-Exports.*	*Total.*	*Exports.*	*Re-Exports.*	*Total.*
Acids: muriatic, nitric, and sulphuric	5,367	23	5,390	1,940	20	1,960
Calcium carbide	Nil	2,787	2,787	600	640	1,240
Salt, rock and other, excluding table preparations	131,200	3,663	134,863	122,720	140	122,860
Sodium carbonate, ash, bicarbonate, and crystals ..	1,316	1,944	3,260	920	1,000	1,920

It will be noticed that these figures show the tendency towards self-support for the period under review, except in the case of acids, and here the total of re-export in both years is so small that it may be a question of one conservative buyer only. It may be added that rock salt was entirely re-exported in 1913, but the bulk of it is home produced in 1921, and all the "other salt" also.

Turning now to the imports, the chief articles are naturally enough what may be called the commoner products, and sodium products are of considerable value; we will give grouped figures as in the case of the export trade, and deal separately with caustic soda, but it must be understood that other sodiums, which space does not permit us to deal with by name, are imported to a considerable yearly value.

IMPORTS OF CERTAIN CHEMICALS INTO AUSTRALIA (CWTS.).

Product.	*Source.*	1913.	1921.
Boric acid	Empire	7,073	8,740
	Foreign countries	120	Nil
	Total	7,193	8,740
Sodium carbonate, ash, bi-carbonate, and crystals	Empire	263,033	330,320
	Foreign countries	553	120
	Total	263,586	330,440
Caustic soda	Empire	97,659	58,960
	Foreign countries	686	2,360
	Total	98,345	61,320

Although Australia is an exporter of salt, a considerable quantity is still bought from outside sources, the total for 1921 (excluding table salt) being 98,480 hundredweights, of which the bulk came from the United Kingdom.

Passing from sodium products to other industrial chemicals, we find the Empire (which practically means the United Kingdom) the chief source of supply for copper sulphate (1921, 619 tons), alums and aluminium sulphate (1921, 500 tons), and cyanides of potassium and sodium (1921, 1,367,908 pounds), both before and after the War, while this is largely the case for ammonium products, except nitrate, of which 222 tons were imported in 1921, chiefly from Norway. The United Kingdom holds its own also in bleaching powder, though the quantity imported in the later year is only 100 tons, but the Commonwealth's imports of calcium carbide and sulphur are drawn almost entirely from extra-Empire sources; the quantity of the former in 1913 was 288,195 hundredweights, of which only 24,383 hundredweights came from the Empire, while the corresponding values (weights not given) for 1921 are £1,544 and nil; in 1920, however, Canada secured a small proportion of this trade. Sulphur is relatively of some importance, the total quantity in 1913 being 603,865 hundredweights, and in 1921 971,500 hundredweights, and the chief sources of supply changed from Japan and Italy in 1913 to the United States and Mexico in 1921.

We may close this section with a reference to the potassium group of chemicals. Far and away the largest in this group is cream of tartar, and since tartaric acid is also an import of some magnitude we will give the figures here for convenience, though tartaric acid, of course, falls into the fine chemical group rather than into the heavy. The details are given on p. 171.

We do not think it necessary to deal in detail with the remainder of this class, but the largest individual items in 1921 are chlorate with 4,520 hundredweights, valued at £11,963, and nitrate (including saltpetre) with 5,580 hundredweights, valued at £11,295. Foreign countries are the chief source of supply for the former, and the Empire for the latter, while the total value of other potassium compounds imported in 1921 is £17,661.

IMPORTS OF CREAM OF TARTAR AND TARTARIC ACID INTO AUSTRALIA (CWTS.).

Product.	*Source.*	1913.	1921.
Cream of tartar	Empire	2,415	18,740
	Foreign countries	39,605	14,820
	Total	42,020	33,560
Tartaric acid	Empire	3,820	2,320
	Foreign countries	5,778	220
	Total	9,598	2,540

We have only been able, in the space at our disposal, to deal with a selection from the many import headings in the heavy chemical class, but the details we have given above will suffice to show that the general trend of the trade is decidedly healthy from an Empire point of view.

§ 5.

COAL TAR PRODUCTS, INTERMEDIATES, AND DYESTUFFS.

No very detailed information is available regarding the export of coal tar products, but we find reference to "naphtha, coal tar, benzene, and benzol," a small quantity of home-produced material being sent to Fiji in 1921; to pitch and tar, which are probably, but not necessarily, derived from coal; and to insecticides, disinfectants, and sheepwashes, which may be taken as at any rate to some extent the products of coal tar. It is not quite clear whether the figures for disinfectants refer to exactly the same products in both years, but they are decidedly interesting, and we give them below together with those for pitch and tar:

EXPORTS AND RE-EXPORTS FROM AUSTRALIA OF PITCH AND TAR AND DISINFECTANTS.

Product.	1913. *Exports*	1913. *Re-Exports*	1913. *Total*	1921. *Exports*	1921. *Re-Exports*	1921. *Total*
	(Cwts.).	*(Cwts.).*	*(Cwts).*	*(Cwts.).*	*(Cwts.).*	*(Cwts.).*
Pitch and tar	4,687	1,181	5,868	39,400	1,060	40,460
	(£).	(£).	(£).	(£).	(£).	(£).
Insecticides, disinfectants, and sheep-washes	1,874	2,565	4,439	25,170	1,116	26,286

Turning now to the import side, the information available is on much the same lines as for exports, but the chief items of interest are pitch and tar, including bitumen, under which heading a quantity of 3,877 tons is shown for 1913, and 1,593 tons for 1921, the United Kingdom being the chief supplier in the earlier year and the United States in the later, and naphthalene, of which 150 tons were imported in 1921, about two-thirds from the United Kingdom.

No information is available regarding intermediates, with the exception of nitrobenzene, of which 5,328 gallons were imported in 1921, but it may safely be taken that this class is negligible. As regards dyestuffs, the export heading

obviously includes every material which can be called a dye, but it may be taken that the re-export figures of £1,180 in 1913 and £20,191 in 1921 refer largely to synthetic colours, and that there is virtually no local production.

The value of synthetic dyestuffs imported in 1913 was £34,287, and in 1921 this figure had grown to £162,498. The chief supplier in the earlier year was naturally Germany, but after the War the United Kingdom is responsible for £136,833 of the total given above.

§ 6.

Fertilizers.

As we have indicated above, the Commonwealth is a producer of some importance in so far as fertilizers are concerned. The chief markets are New Zealand and Fiji, though Japan and the Dutch East Indies are good customers for sulphate of ammonia.

The trade in 1921 was practically all genuine exports, the only re-export worth mentioning being nitrate of soda. It is a little surprising here to find that, out of a total of 290 tons, 204 are put down as Australian produce, and in 1913 we find the same thing, though the quantity is only 7 hundredweights out of a total of 10,154 hundredweights.

In 1913 quantities of superphosphate, rock phosphate, and guano were re-exported, but the amounts were relatively unimportant, and we will therefore not trouble to detail them.

The staple articles of export are sulphate of ammonia, bone dust, and superphosphate, and the following table shows the statistics in this connection. In order to save space as far as possible we have slightly altered the form in which the details are set out:

Exports of Australian Produced Sulphate of Ammonia, Bone Dust, and Superphosphate (Cwts.).

	1913.			1921.		
Product.	*Empire.*	*Foreign Countries.*	*Total.*	*Empire.*	*Foreign Countries.*	*Total.*
Sulphate of ammonia ..	8,186	37,881	46,067	17,840	137,580	155,420
Bone dust	80,227	6,068	86,295	32,300	1,020	33,320
Superphosphate	233,308	42	233,350	26,720	Nil	26,720

It may be assumed that better world trade will enable Australia considerably to increase her exports of, at any rate, the last two products in the above table.

As regards less important fertilizers, rock phosphates to the value of £1,960 were sent to New Zealand in 1921, the quantity being 12,900 hundredweights against a total demand from that country in 1913 of 16,731 hundredweights, while various other fertilizers to a total value of £11,953 were shipped in 1921, considerably more than half of this amount being bought by foreign countries.

Turning now to Australia's imports in this class, the chief items are rock phosphates and guano not in rock form, the details being as follows:

IMPORTS OF ROCK PHOSPHATES AND GUANO INTO AUSTRALIA (CWTS.).

Product.	*Source.*	1913.	1921.
Rock phosphates	Empire	2,220,845	3,255,800
	Foreign countries	979,803	Nil
	Total	3,200,648	3,255,800
Guano, not in rock form	Empire	26,819	704,040
	Foreign countries	Nil	Nil
	Total	26,819	704,040

The bulk of both these items came in 1921 from Nauru. The only other fertilizer of which the imports are worth mentioning is nitrate of soda, though considerable quantities of superphosphate were imported up to the War. This trade, however, has been negligible since 1914, and we think it may safely be taken that the Commonwealth is now self-supporting in this respect.

In the case of nitrate of soda, Chile is naturally enough the only serious supplier, and the pre-war imports total 66,783 hundredweights against a quantity in 1921 of 50,220 hundredweights.

§ 7.

DRUGS AND MEDICINAL CHEMICALS.

There is practically no information in the export returns regarding any of the articles with which we are dealing under this heading, but under the classification "Medicines" are shown exports of £9,484 and re-exports of £19,365 in 1913, giving a total of £28,849. The corresponding figure for 1921 is £128,226, of which £97,506 represents Australian produce, only £30,720 being re-exported. We think the change in this class during the War must be considered a creditable achievement.

We should also like to comment here on another praiseworthy effort, although the products do not, perhaps, come strictly within the scope of this volume.

Bacteriological products and serums to a value of £30 were exported in 1913, together with re-exports totalling £1,799; and the similar figures for 1921 are £13,955 and £1,552, which, taken together, seems to point to a considerable expansion in the production of a class of articles the manufacture of which is a matter of some difficulty.

Proceeding now to consideration of the imports in this group, we find comparative statistics available for morphia and its salts, the import of which has increased from 608 ounces in 1913 to 1,863 ounces in 1921, the United Kingdom being the chief supplier; for opium for medicinal purposes, the quantity of which has decreased from 922 to 829 pounds; and for saccharin and similar articles, of

which 5,637 pounds were entered in 1913 against a corresponding figure of 3,082 pounds in 1921.

Other imports, of which we have only been able to trace particulars for 1921, are: chloroform, 440,876 ounces, valued at £7,780; iodine, 3,123 pounds, valued at £3,021; iodides, 9,033 pounds, valued at £7,502, in which the United Kingdom is the chief source of supply, together with the following articles, the bulk of which was brought in from foreign sources: formaldehyde and paraformaldehyde, value £5,509; lactose, value £20,644.

The lactose was imported about two-thirds from the United States and the balance from the Netherlands, while the United States was responsible for the better part of the formaldehyde, although the quota of the United Kingdom was better than in the previous year.

§ 8.

The import trade of the Commonwealth may be taken as partly in the hands of the large merchant houses, but in the case of the home and export sections the tendency is, as we have noted in the case of other Dominions, for the producer to look after his own interests as far as possible. None the less, here, as in other countries, the merchant undoubtedly plays his part also.

Turning now to the question of chemical consuming trades, the products we have instanced as being the chief imports will have given a fair idea of the industries for which their bulk is destined. To take this a step further, we may mention that the Year Book instances, for the year 1920-21, 2,453 factories connected with food and drink, etc., 164 tanneries, 97 wool-scouring establishments, 62 soap and candle factories (which consumed between them 120,882 hundredweights of alkali), and 305 chemical and paint works, together with woollen and cotton mills, dyeing establishments, ice and refrigerating works, paper makers, etc.

To sum up, Australia is to-day a fairly important consumer of chemicals; but her manufacturing industry, as a whole, has great possibilities of expansion, with commensurate needs in the chemical line, and it remains to be seen in what proportion she will fill these demands for herself.

§ 9.

We are indebted to the official Year Book of the Commonwealth of Australia and other official publications for much of the information we have given in this chapter, and, since the completion of this volume, the Official Secretary of the Commonwealth has provided us with certain statistics for the year 1921-22, the most important of which we have added to the preceding pages.

CHAPTER XXVII

NEW ZEALAND

§ 1.

New Zealand is at present almost entirely a supplier of natural wealth to the Empire, as is evident from the fact that out of the total domestic export for 1921 of £43,615,458, manufactured products only accounted for between 400 and 500 thousand pounds.

Nor does it seem likely or desirable that the Dominion should enter to any large extent the manufacturing field. She has succeeded over a long period of years in maintaining a favourable balance of trade under the present system, and it would appear a pity to depart from this, which is of proved worth, and embark upon the uncertain and overcrowded seas of manufacture.

Such factory work as is carried on consists chiefly of working up agricultural or pastoral produce—butter and cheese making, meat-freezing, flax-milling, etc., or ministering to the domestic needs of the population, and on the whole only the simplest forms of industry are practised, the bulk of manufactured needs being imported.

The total number of establishments shown in the Dominion for 1920-21 is 4,804, and the chief centres of activity are Auckland and Wellington, with Canterbury and Otago a good second. The chemical section is not important enough to have very full statistics of its own, but the total number of boiling-down and manure-making works is sixty-two, and of chemical manufacturers seven.

Considering the size of the Dominion, New Zealand may be said to have an excellent statistical organization, which publishes various well-set-out statistical reports of one sort and another.

§ 2.

The chief chemical resources worked upon a commercial basis are sulphur, manganese, tungsten, and iron ore, while many other minerals, such as copper and tin ores, are known to exist, but are not worked to any large extent. It is stated, however, that the known mineral reserves of the Dominion are not great as compared with those of many other countries, the exception being iron ore. Phosphate rock also exists in several places, but is only worked by one company.

Coal exists in New Zealand and is mined, but it is considered probable that the resources at present known will be exhausted in the course of a century or so, at any rate in so far as bituminous coal is concerned. The great hope of the country in this direction, however, appears to be its water power, and the Government is obviously most progressive in this respect, giving great attention and encouragement to the developing of hydro-electric power stations, etc. All water power is in the first place a Government monopoly, but the State delegates its powers to local authorities, companies, and individuals, as well as carrying out schemes on its own account. It would appear that before long little power, heat, and light will be used in the Dominion other than that derived from water

power in the first place. The total horse power in use at March 31, 1922, is given as over 56,000, and there remain more than ample reserves of power upon which to draw.

§ 3.

We have not succeeded in tracing much information regarding the production of chemicals, etc., in New Zealand, but the production of phosphate rock at Clarendon and Milburn, which we have mentioned above, was 6,012 tons in 1921. Meat factories produced, in 1921-22, 106,292 hundredweights of bone dust and bone manure, 394,271 hundredweights of other manure, which may be surmised to be blood and tankage, and 3,495 hundredweights of horns, hoofs, etc., while boiling-down and manure works turned out in the same period bone dust and bone manure to a total of 38,101 hundredweights and 404,930 hundredweights of other manure.

Soap and candle factories were responsible for an output of 1,833 tons of soda crystals and 76 tons of glycerine, while it is worth noting that their consumption of caustic soda, soda ash, and potash is given as 1,614 tons. Finally, the gas industry sold 2,462,424 gallons of tar in 1921-22, together with other residuals worth £9,151.

These particulars complete the information we have been able to obtain in regard to production, and we may pass on to consideration of the external trade. It should be noted that statistics, unless specially stated to the contrary, refer to the calendar years, while the Empire figures so largely as the source of supplies that we have not given any details in this respect. If, however, the main bulk of any supply is derived from extra-Empire sources, a note will be made to that effect.

§ 4.

New Zealand's export of home-produced material is negligible as a whole, but mention may be made of gas or ammoniacal liquor and a few tons of soda crystals.

The import headings naturally cover a good deal of ground, and to be as brief as possible we will show in tabular form the information relating to the chief acids and alkalies imported, bearing in mind that boracic acid is only shown for 1921, when the amount imported was 203,633 pounds, valued at £7,920.

IMPORTS OF CERTAIN ACIDS AND ALKALIES INTO NEW ZEALAND.

Product.	1913.		1921.	
	Quantity (*Lbs.*).	*Value* (£).	*Quantity* (*Lbs.*).	*Value* (£).
Acetic acid (30 per cent.)	367,187	3,816	132,703	2,709
Sulphuric acid	517,676	3,284	244,630	3,049
Tartaric acid	152,888	8,081	110,725	12,927
	(*Tons*).		(*Tons*).	
Salt	25,275	74,398	18,597	96,903
	(*Cwts.*).		(*Cwts.*).	
Caustic soda	19,302	13,972	9,650	17,540
Sodium carbonate and bicarbonate	18,119	7,223	15,802	10,277
Soda ash	21,861	6,597	14,627	7,300
Sodium silicate	8,684	3,427	5,214	4,494

Apart from the articles mentioned above, there are only a few with which we need deal. Cream of tartar for 1913 amounted to 1,044,831 pounds valued at £41,091, but like the products just named it is considerably down in the later year at 702,421 pounds to a value of £42,671. As is to be expected, foreign countries constitute the chief source of supply.

Comparative statistics are also available for calcium carbide, cyanides of potassium and sodium, and sulphur, and are shown in the following table:

IMPORTS OF CERTAIN CHEMICALS INTO NEW ZEALAND.

Product.	1913.		1921.	
	Quantity (Tons).	*Value (£).*	*Quantity (Tons).*	*Value (£).*
Calcium carbide	2,316	32,698	864	23,403
Cyanides	295	25,482	206	30,505
Sulphur	1,925	10,517	4,622	18,295

It should be noted that the chief supplies of calcium carbide and sulphur were drawn from foreign countries in 1913, but in the later year Canada had captured the bulk of the trade in the former, the latter remaining a foreign supply.

We may conclude the section by a reference to borax, anhydrous ammonia, and glycerine. The first named is only noted for the post-war year, when 2,432 hundredweights were brought in, while ammonia figures at £5,374 and £29,728. Value only is noted in the case of glycerine also, the total for 1913 being £4,242 and for 1921, £5,516.

§ 5.

FERTILIZERS.

Some small exports are noted in this class, but it is not necessary to go into details, as imports form by far the largest part of the trade. More information is available in the later year than in the earlier, but we think the following table will make the whole position quite clear:

IMPORTS OF FERTILIZERS INTO NEW ZEALAND (TONS).

Named Manures.	1913.	1921.
Basic slag	—	12,885
Superphosphate	—	9,836
Rock phosphate	—	44,899
Bone dust	5,817	4,320
Guano	8,792	5,706
Sulphate of ammonia	—	2,137
Potash manures	—	1,481
Total all manures	103,925	82,484

New Caledonia is the chief source of guano in both years, while sulphate of ammonia is chiefly American, basic slag Belgian, and potash manures the produce of various foreign countries.

§ 6.

We may deal very shortly with the classes upon which we have not already touched. The export section is negligible, while import information is, on the whole, of a very general character.

Carbolic acid to a small value was imported in both years, while disinfectants (£17,316 and £27,032) are a large item, but it is uncertain to what extent coal tar figures in their composition. Dyestuffs stand at £15,735 for 1913, and £98,247 for 1921. Germany is, of course, the chief source in the earlier year and gives place to the Empire after the War, though the total named above includes £13,863 from Germany entered on Government account, and no distinction is made in either year between coal tar and other dyes.

Finally, entries are noted of saccharin, medicinal barks and preparations, strychnine and other products, but we do not consider it advisable to give space to further details.

§ 7.

New Zealand's re-export trade in chemical products is as a whole insignificant, but a certain trade is done with various islands of the Pacific. The class of products shipped will be sufficiently obvious to need no commentary here.

The import trade is largely in the hands of importing houses, and our general remarks regarding this section in Australia may be taken as applying substantially to New Zealand also, while the various items we have named as being the chief imports will give a clear indication as to the general type of local consumption.

We have given some figures in regard to the soap trade, while the refrigerating industry doubtless accounts for the anhydrous ammonia entered. Two baking powder works are listed, and tanning and wool-scouring are also relatively considerable branches of activity, while mining, a most important branch of the Dominion's industry, will account for the heavy import of cyanides.

CHAPTER XXVIII

BRITISH NEW GUINEA. FIJI. NAURU AND OCEAN ISLANDS

BRITISH NEW GUINEA

PAPUA, formerly known as British New Guinea, is under the authority of the Australian Commonwealth by Order in Council, while the territory of New Guinea (formerly German New Guinea) is mandated to the Commonwealth.

It will be convenient to treat the two areas as one, which they are in a geographical sense, and it may be added that but little is known about their resources at present, and practically no statistical information is available for the purposes of this book.

British New Guinea is rich in vegetable resources such as sugar cane, cotton, rubber, palms, etc., which are indigenous to the country, while the coconut,

rubber, and hemp are grown commercially. It does not seem likely, however, that artificial fertilizers will be needed.

The mineral resources discovered so far include sulphur, chromite, manganese, coal, iron, copper, etc., while phosphates are found in the Purdy Islands. Water power also is available, but it may be taken that only the most superficial examinations of the Colony have been carried out so far, and much remains to be learnt. It would appear also that shortage of labour may become a difficulty tending to retard development.

We have given above a sufficient indication as to the general type of the exports, no chemicals being noted, while we can trace no complete and detailed import figures. Medicines and drugs, however, were imported into the mandated territory to a value of £11,162 in 1913 and of £10,300 in 1920-21.

FIJI

The colony of Fiji consists of a considerable number of islands, of which the largest is known as Viti Levu. It is a well-watered, fertile area, and the chief exports are sugar copra, and fruit. Rubber and hides are also of interest from our point of view.

Various mineral resources such as antimony, manganese, etc., have been noted, but we cannot trace any mention of their being worked, nor is the area notable for any other resources from a chemical point of view.

The imports are on the whole of the obvious order of household necessities and drugs, but manure totalling 1,316 tons, valued at £14,379, was imported from Australia in 1913, with a slightly larger quantity in 1921. It is not clear that these figures refer to chemical fertilizers, but they are mentioned as being the biggest named item possibly belonging to the chemical group. A fair quantity of salt is also brought in, and opium has increased from 253 pounds in the pre-war year to 538 pounds, the value rising from £295 to £1,485.

Practically all supplies come from Australia, as is natural enough, and no export trade is noted which is worth detailing here.

NAURU AND OCEAN ISLANDS

Nauru, or Pleasant Island, was in German hands at the outbreak of war, and was occupied by Australian troops in November, 1914. It is at present administered by an official appointed by the Australian Government in accordance with an agreement made by the British, Commonwealth, and New Zealand Governments, and its importance lies in its deposits of phosphate rock.

These are worked by the British Phosphate Commission, which also mines the phosphate deposits of the other island named above, Ocean Island, or Paanopa, in the Gilbert and Ellice Islands Colony, the interests of the Pacific Phosphate Company having been bought by the three Governments we have mentioned for £3,500,000. The money was subscribed in the proportions of 42, 42, and 16 per cent. respectively, and the three countries are entitled to receive the output in the same proportions.

The deposits are of higher quality than any large deposits elsewhere, averaging as shipped 85 to 88 per cent. tribasic phosphate of lime, and the output of the two islands in 1913 amounted to about 350,000 tons. During the War this fell considerably, as is natural enough, but 1920 saw a recovery which was maintained, the output for the year 1920-21 being 364,251 tons. It may be added that the proportional division of the output was not adhered to for this year, as by far the largest part of the output was shipped to Australia.

With this chapter we finish Part II., or the geographical section of this volume. In Part III., which follows, will be given our general conclusions from the facts elicited in the previous parts and such constructive suggestions as we are able to make for the greater prosperity of the Empire in so far as its chemical trade is concerned.

PART III

CHAPTER XXIX

SUMMARIZED CONCLUSIONS. ARGUMENT

§ 1.

In the preceding chapters we have given as full an account as is possible in the space at our disposal of the chemical needs and, in the widest sense of the word, resources of the Empire, and it will have been sufficiently evident from the statistics we have noted that much of the demand for chemicals which existed in the years before the War is now depleted, while of the remaining trade enough has been lost seriously to threaten the Empire's, and especially the United Kingdom's, pride of place as leader of the chemical industry of the world.

In this chapter will be summed up the facts thrown into relief by our survey of the various parts of the Empire. We will examine the causes at present operating against the self-support of the Empire in its chemical demands, and suggest, in so far as lies in our power, means to attain the end so desired by every section—viz., an Empire which can satisfy all its chemical needs for itself and must depend upon no outside sources which are liable to be cut off in the event of war.

§ 2.

It may be stated without fear of contradiction that coal, or hydro-electric power, and salt are the basic necessities for the establishment of a chemical industry, for, without these, other resources are of no avail.

No great amount can be done, however, without sulphur and chalk in addition to salt and power, while potash and metallic ores may be taken as next in order of importance.

Until recent years it would have been necessary to include nitrogen in this catalogue of mineral resources of an essential character, and nitrate of soda from Chile may still be taken as forming the chief source of nitrogen in our manufacturing processes. The position to-day, however, is undoubtedly in a transition stage, though it would, perhaps, be too much to say that Chile's supremacy as a source of nitrogen is threatened; for all that, it is clear that Chile has much to fear from the Haber-Bosch process for the synthesis of ammonia from the atmosphere, which attained an unenviable notoriety recently as a result of the Oppau explosion, and from the hydro-electric fixation of nitrogen from the atmosphere, in which Norway has apparently gained a lead.

From the point of view of the Empire, it would appear that the nitrogen fixation process will be the source of this essential element in countries possessed of water power, and the process is already started in Canada. In the United Kingdom and other areas relatively deficient in water power, the Haber process, or some modification thereof, may come to the fore, since it can be carried out on a coal basis, without the sources of especially cheap electricity which are essential to the Norwegian process.

To sum up, then, the basic needs of the chemical industry are almost entirely of a mineral order, and, indeed, a relatively considerable manufacturing industry may be built up with only the first four which we have named—power, salt, sulphur, and chalk—since upon these may be based the manufacture of alkalies, which may, perhaps, be considered the most important section of chemical production.

Of these raw materials, the only one at present imported to any large extent by the manufacturing countries of the Empire is sulphur, and, so far as is known to-day, no Empire source of natural sulphur is in existence to compete with the Italian and American sources of supply. Sulphide ores are, however, available in quantity, and wherever these are found it will be obvious that sulphur may be obtained.

§ 3.

If we accept these premises—and it is difficult to see how they could be considered of a contentious character—it will be clear that in every large Dominion there is the potentiality of a chemical manufacturing industry. We need not consider the smaller sections of the Empire, since the manufacture of chemicals should only be carried on on a large scale, as we shall see in a later section of this chapter.

We have noted coal, salt, and lime in Canada, Australia, South Africa, and India, and even in this small volume sufficient of the other mineral resources of these countries has been mentioned to make it obvious that the production of almost every chemical need is well within their material powers apart from the considerable alkali and coal tar industries which could be built up with only the basic materials.

The question, then, is not one of natural resources, but it is, in our opinion, one of economic conditions and resources, and we are faced with two alternatives. We may either aim at each section's producing its own needs with local raw materials, or we may endeavour to centralize the manufacturing end of the chemical industry, using the various parts of the Empire as sources of raw material, and it is this latter course which we believe to be the most beneficial to the Empire as a whole.

§ 4.

We will deal first with the direction of activity which we consider the less satisfactory—the expansion of existing chemical manufactures and the starting of new ones.

It is usually accepted that the early years of a new industry of this order are dependent upon the local demand for its productions, and this local demand is,

in this case, obviously dependent upon the expansion of other sections of manufacturing industry, since the vast bulk of chemical manufactures is used in the production of other commodities, but little being delivered direct to the private individual.

It follows, therefore, that the local demand for chemicals is invariably bound up in the growth of population—to increase consumption generally—and the development of communications—to facilitate distribution—which implies a very slow rate of growth for a chemical industry in a new country.

It may be argued that the aim of every manufacturer should be to develop external trade, and that the Dominions should, therefore, endeavour to build up a chemical manufacturing industry the first object of which is to produce commodities for sale in the markets of the world, and as a general statement of policy this is perhaps correct.

In the case of this branch of industry, however, there are certain practical considerations which make it a difficult matter to pursue this policy with any hope of success. To start with, the production of chemicals and allied products calls for scientific ability of the highest order, together with much experience in the practical operation of manufacturing processes.

It is not to be doubted that our great Dominions possess scientists of more than sufficient attainment to supply the theoretical knowledge that is required, but it would appear doubtful whether the experience that is available is wide enough and of long enough duration to permit of the production of chemicals on a basis of world-competition.

This question of experience cannot be overrated in its importance to the subject under discussion. The classic instance is that of coal tar dyestuffs, in which the composition and theory of manufacture of almost every colour in general demand were known to every chemist before the War.

Every chemist interested in the coal tar section had at some time or other made a number of colours in the laboratory, as has every student to-day, and yet when the War made the production of colours a necessity to Britain, it was some years before products worthy the name of dyes were generally available, and it was not until quite recent times that the British manufacturer could be counted upon to deliver colours genuinely equal to the German products and in absolutely unvarying quality. To-day, Britain has nothing to fear from any competitor in the world in so far as concerns the quality and variety of colours produced, but this is a monument to the devoted and intense study of the chemist in the national wartime effort, and does not in the least weaken the principle that many years of works experience, in addition to scientific knowledge and ability, are needed to make a practical works chemist.

We have put the extreme instance in the case for experience, but the principle holds good all through the chemical industry.

The second essential is large production. Output on a large scale gives better buying facilities for raw material of every sort apart from other obvious advantages and from the fact that the manufacture of any chemical or allied product should be a continuous process—in a word, large production means low overhead charges and therefore low selling prices.

Our contention, therefore, is that the newer countries have not the experience necessary to produce cheaply, and without cheap production they cannot hope to compete in the world markets and lead up to the second essential, large production. It follows that artificial aids are necessary if a chemical industry is to be built up, and this is proved true by the fact that the Dominions with any chemical manufacturing trade are highly protectionist, while their products only have to compete with those of other countries which have to carry heavy freight and charges in addition to prime cost and duty. An exception to this latter state of affairs may be cited in the case of Canada, with the United States ready to hand as a supplier. Even here, however, the local manufacturer is assisted by a heavy tariff.

It thus appears correct that any Dominion chemical manufacturing industry must depend for its early existence on the local demand, and the experience that is the first essential of world competition must be gained at the expense of the local buyer, with the result that the products of every industry using chemicals—or in practice 99 per cent. of the production of the country—must be rendered higher in cost and, therefore, less competitive in the markets of the world.

§ 5.

Destructive criticism is easy, and the reader will rightly consider that our argument so far has been entirely of a destructive character. Our constructive policy, in so far as the Dominions are concerned, lies in the direction of expanding the chemical consuming, rather than the chemical producing, industry.

The expansion of producing activities as a whole is, we submit, the end to be desired; and the policy which we would urge as the most satisfactory to the Empire as a whole in the present, and to the Dominions themselves in the future, is to concentrate upon the more immediate exploitation of their natural resources, such as timber, hides, oil seeds, etc.

The successful conduct of all manufacturing to-day is more and more dependent upon the proper utilization of research and expert knowledge. It will surely be agreed that the manufacture of chemicals calls for knowledge of a more profound character, and experience of greater duration and breadth, than almost any other branch of manufacture. Moreover, if we accept the point made above, that local industry is in the first place dependent upon local demand, the local demand in a new country must always be preponderantly for articles which pass directly into public consumption rather than for the products of such an industry as the chemical industry, which exists for the most part to supply the producers of other articles.

If a policy of overseas industrial expansion is to be pursued, the very fact that other classes of industry are of what we may call a simpler character than the chemical and dyestuffs industry tends in itself to put the newer producer on a more equal footing with his more experienced competitor and so to render him the sooner competitive in the markets of the world, while cheap chemicals also form a useful aid to this end, and therefore to the general expansion of industry.

§ 6.

The first part of our argument may now be summed up by saying that, in our view, the greatest good to the Empire as a whole, and not least to the individual Dominions, lies in the expansion of their general productivity, and this expansion will be the quicker and the greater if it is assisted by the import of cheap chemicals rather than the local production of material at—of necessity—high prices.

It must be clearly understood that nothing we have written is intended to debar or deter the Dominions from eventually producing their own needs in this direction. Our contention is not that the establishment of local production is undesirable, but that the time is not yet come, and that it will come the sooner if encouragement is given rather to other branches of industry for the present. Moreover, as we hinted in the opening chapter of this volume, the prosperity of the Dominions is so bound up in the prosperity of the Mother Country, which is itself to a large extent dependent upon its chemical industry, that the greatest good for the whole Empire lies in measures calculated to increase the prosperity of the industry in the United Kingdom. This is an immediate reason for the course of action which we advocate, but the larger growth of Dominion chemical industry under natural and satisfactory, instead of artificial, conditions is the ultimate end.

§ 7.

The policy, based upon these premises, which we consider the wisest, consists in regarding the United Kingdom as the great chemical manufacturing and distributing organization of the Empire, and the Dominions as the suppliers of the raw material worked up.

The Mother Country may claim this position in the light of more than a century's experience of the manufacture of chemicals, and such a policy, fully carried out, would give effect to that sound desire of all traders, the running of a contra-account, and would result in a completely self-supporting Empire in so far as the chemical industry is concerned. It would be fair to both parties to the bargain and would, we believe, lead to better and cheaper supplies of chemicals with consequent benefit to the general industry of the Empire as a whole.

§ 8.

Leaving the question of local production, with which we have dealt at sufficient length, we may consider the external section of the trade, in which we have noted in our statistical tables a considerable loss of business with countries outside the Empire, and the first question which springs to mind in this connection demands the reasons for this unhappy state of affairs.

It is not due to any inability to manufacture the articles needed. Admittedly this was the case before the War in certain directions. Dyestuffs and certain fine chemicals and drugs are, of course, the chief examples, but the national war-time effort resulted in an enormous increase in our knowledge, our manu-

facturing ability, and our manufacturing resources, and there is to-day practically no chemical product, using the words in their widest sense, which cannot be obtained from Empire sources, both as regards raw material and manufacture. A few specialized products are, perhaps, not produced within the Empire, but these are absolutely insignificant, and their production is purely a question of demand, not ability.

The fact that the Empire to-day is not self-supporting is entirely a question of competition, and, taking as conceded our policy that the United Kingdom is to be the Empire's source of manufactured chemicals, we will examine the causes contributory to the price of those products in which the Mother Country cannot compete.

§ 9.

The chief disadvantages under which our manufacturers are at present labouring may be briefly stated as debased currencies; low wages and longer hours in other countries; high taxation and, as we outlined in our introductory chapter, largely increased world production together with lessened demand.

We will consider these problems one by one, and it appears clear that the solution of the first does not rest with the manufacturing industry. It is not our part to enter upon the discussion of topics of a contentious character, nor are we in favour of interference with the working of economic laws, but it certainly seems that the present very exceptional circumstances call for exceptional—and, perhaps, normally undesirable—counter-measures.

The second trouble we have instanced, that of labour's ratio of hours worked to pay demanded, is, again, a question for solution outside the manufacturing community, as is the high taxation at present in force, but we cannot refrain from remarking that if labour would give of its best—and the best of British labour is very good—there is nothing whatever to be said against short hours and high wages. The whole matter is simply one of output, and if the output be there the wage can be high and the hours short.

The final difficulty of increased world production does to some extent rest with the manufacturer. It is true that he cannot of his own volition prevent his rivals from producing, nor is it desirable that he should. He can, however, by continual research, the adoption of the latest processes, the elimination of waste, and the scrapping of inefficient plant, render his manufacturing costs lower, and so make his goods more competitive, the immediate result being increased demand for his goods and less for those of his competitors.

§ 10.

The foregoing section covers, in so far as the present volume is concerned, the manufacturing end of the industry, but the problem does not cease with the production of the goods at the works.

It is at all events theoretically possible that the production of the goods should be completely efficient and in every way perfect, and yet not one ounce be sold through faults in either the selling organization or the transport system.

Taking the latter, and touching upon the delivery from works to shipping port in the first place, the existing trouble does not seem to be so much one of high rates—though reductions would certainly assist matters and seem in some directions to be overdue—as of lessened efficiency on the part of the railway companies. Without possessing personal knowledge of railway organization, we understand that it was a point of honour with the goods staff before the War to clear out traffic as fast as it was tendered, and it is certain that in those days the time taken over delivery of goods to any destination was a matter of calculation rather than of hoping for the best, as it is to-day. Waggon hire, whether in the form of payments to the railways or interest on capital, is high, and every day wasted *en route* means additional—and totally unnecessary—overhead charges to be borne by the goods. It may be argued that goods can be sent by road, and road transport is undoubtedly useful, but it has certain limitations, and we believe that railway transport will always be preferred by the chemical industry except for comparatively short distances.

Turning now to the transport of goods overseas, we are apparently faced with a difficult problem. We are told that the shipping companies are working at a loss, yet the fact remains that it is to-day noticeably cheaper to ship goods to certain continental ports and tranship there, than to ship direct to our customers by our own lines. This does not appear to be a matter of debased currencies, as the Dutch lines are equally cheap with the German lines for reshipping the goods. Whatever the reason, the fact remains that existing high freight rates are tending to drive trade away from the United Kingdom.

§ 11.

We may now deal with the selling side of the industry, which, after all, is nearly as important as the production. Not quite, however, since good and cheap products will sell with an inefficient sales organization, whereas no amount of work and efficiency on the part of the sales staff will compensate for poor quality in the goods to be sold.

The Englishman, both manufacturer and merchant, has an enviable reputation throughout the world for the quality of his goods and the honesty of his dealing. It is an unfortunate fact, however, that it is far easier to sell a reputation than to gain it, and especial care must therefore be taken to send to the overseas and foreign buyer material of even better quality—if this is possible—than usual, and to do everything that can be done to make the buyer realize that the first object is to give him—putting it popularly—a square deal for his money.

The next point is that of studying the tastes and needs of the individual buyer, whose desires should be consulted in every way possible. The buyer should be pursued more intensively than before the War, and he should be given the fullest possible knowledge of the wide variety and supreme quality of British chemical products.

Finally—and in our opinion most important of all—every endeavour should be made to reduce selling costs, and in this connection we would instance two cases of association of interests: the one, the British Sulphate of Ammonia Association,

which is a central selling and propaganda department, leaving the individual works free in every way to manage their affairs apart from selling; the other, British Glues and Chemicals, Ltd., which is a complete fusion of a number of previously existing interests, reorganized under one management.

It is not for us to argue the respective merits of the two systems, but we do wish to make this point: one of the greatest steps that could possibly be taken would be, in our opinion, a greater association of interests in the chemical industry than exists at present.

Such association, or rather associations—for it would be necessary to form a separate organization for each large branch of this great industry, should in our opinion embrace a central selling and propaganda department, which would also be a central buying department; should embrace, too, the pooling of works knowledge and a central research laboratory and reference library. The immediate benefits would lie in reduced selling costs and reduced competition, both in buying raw materials and in selling the finished goods, but it is our belief that the immediate gain would be completely dwarfed in the ultimate benefits won from the industry's working as a whole for the common good instead of each member's trying to plough his little furrow by himself.

The pooling of knowledge, although it is contrary to natural instincts, is regularly carried out with the utmost success in America, and it might be suggested in passing that the Government could play a part by encouraging research in this country. That it could accomplish much in this direction is shown by the results of Government assistance to research in the industry in Germany.

But the whole burden of our message may be stated as "Organize, organize, and then organize again." Competition to-day is far fiercer than it ever was at any time before the War, and only by the sinking of self and working together for the common good can the prosperity of the Empire be insured through the United Kingdom's regaining and holding its rightful place as the greatest chemical producing organization in the world.

PART IV

CHAPTER XXX

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Canadian Chemistry and Metallurgy (monthly). Westman Press, Ltd., 57, Queen Street West, Toronto.

The Official Year Book of the Commonwealth of Australia. McCarron Bird and Co., Melbourne.

Australian Oversea Trade Bulletins (Imports and Exports). McCarron Bird and Co., Melbourne.

Australian Production Bulletins. McCarron Bird and Co., Melbourne.

The New Zealand Official Year Book. Eyre and Spottiswoode.

Statistical Reports on the Trade and Shipping of New Zealand. The Government Printer, Wellington.

Statistical Reports on the Industrial Manufactures of New Zealand. The Government Printer, Wellington.

The Official Year Book of the Union of South Africa. The Government Printer, Pretoria.

Directory of Industrial Establishments (South Africa). The Government Printer, Pretoria.

Statistics of External Trade of the Union of South Africa, Northern and Southern Rhodesia, and South-West Africa. The Government Printer, Pretoria.

Industrial Prospects in South Africa. The Government Printer, Pretoria.

Annual Statements of the Sea-Borne Trade of British India. Supt. Government Printing, Calcutta.

Handbook of Commercial Information for India. By C. W. E. Cotton, I.C.S. Supt. Government Printing, Calcutta.

Punjab Industries, 1911-1917. By A. C. Badenoch, I.C.S. Supt. Government Printing, Lahore.

NOTE.—It should be understood that the books named above are merely a selection from the many which are available, and they are those which, on the whole, contain a fair amount of matter relative to the subject of this volume.

It will be found that most of the literature relating to any given Dominion will be accessible at the office in London of that Dominion, and the reader who is desirous of amplifying the necessarily condensed information contained in the present volume is recommended to seek assistance from the Dominion officials, who will be found most courteous and helpful. He will be allowed to take down from the shelves and read any volumes he desires, and in the case of the Colonies the same remarks apply, but the source of information will be the library at the Colonial Office.

LIST OF ASSOCIATIONS COMPRISING OR INCLUDING IMPORTERS AND EXPORTERS OF CHEMICALS, ETC.

Federation of British Industries, 39, St. James's Street, S.W. 1.

Association of British Chemical Manufacturers, 166, Piccadilly, W. 1.

National Sulphuric Acid Association, Ltd., 166, Piccadilly, W. 1.

The British Chemical and Dyestuffs Traders' Association, 22, Buckingham Gate, S.W. 1.

The Association of Tar Distillers, 166, Piccadilly, W. 1.

The National Benzole Association, 30, Grosvenor Gardens, S.W. 1.

The British Disinfectant Manufacturers' Association, 166, Piccadilly, W. 1.

Association of Manufacturing Chemists, Ltd., 14-17, Holborn Viaduct, E.C. 1.

British Essence Manufacturers' Association, 181, Queen Victoria Street, E.C. 4.

Drug and Fine Chemical Manufacturers' Association, 18, Tavistock Square, W.C. 1.

National Drug and Chemical Union, 31-33, High Holborn, W.C. 1.

The Fertilizer Manufacturers' Association, Ltd., 69-70, Fenchurch Street, E.C. 3.

The British Sulphate of Ammonia Federation, Ltd., 30, Grosvenor Gardens, S.W. 1.

The Sulphate of Ammonia Export Traders, Ltd., 16, Mark Lane, E.C. 4.

The Canadian Fertilizer Association, 62, Richmond Street West, Toronto, Canada.

The Canadian Association of British Manufacturers and their Representatives, 39, Richmond Street East, Toronto, Canada.

The Canadian Manufacturers' Association, 1401, Bank of Hamilton Building, Toronto, Canada.

The Manufacturers' Association of British Columbia, 929, Granville Street, Vancouver, Canada.

The Federated Chamber of Industries, Box 667, Cape Town, South Africa.

LIST OF INSTITUTIONS, ETC., FROM WHICH INFORMATION MAY BE OBTAINED REGARDING THE CHEMICAL INDUSTRY AND THE NATURAL RESOURCES UTILIZED THEREIN.

The Imperial Institute, South Kensington, S.W. 7.
The Imperial Mineral Resources Bureau, London, S.W. 1.
The Library, Board of Trade, London, S.W. 1.
The Department of Overseas Trade (Development and Intelligence), London, S.W. 1.
The Library, British Museum, London, W.C.
The office of the High Commissioner for Canada, Kinnaird House, London, S.W. 1.
The Dominion Bureau of Statistics, Ottawa, Canada.
The office of the High Commissioner for Newfoundland, London, S.W. 1.
The office of the High Commissioner for the Commonwealth of Australia, Australia House, Strand, W.C. 2.
The Commonwealth Bureau of Census and Statistics, Melbourne.
The office of the High Commissioner for New Zealand, Strand, W.C. 2.
The Government Bureau of Statistics, Wellington, New Zealand.
The office of the High Commissioner for the Union of South Africa, London, S.W. 1.
The Union Office of Census and Statistics, Pretoria, South Africa.
The office of the Government of Rhodesia, London, W.C. 2.
The office of the Indian Trade Commissioner, London, S.W. 1.
The Commercial Intelligence Department, Council House Street, Calcutta.
The Commercial Museum, Calcutta.
The Geological Survey Department, Calcutta.
The Department of Statistics, Calcutta.
The Malay States Information Agency, London, E.C. 4.
The West India Committee, London, E.C.
The Library, Colonial Office, London, S.W. 1.

NOTE.—The foregoing does not purport to be a complete list of Empire sources of information, but it may be taken that such information as cannot be obtained from the sources named above is scarcely of practical moment, or is generally not available to the public.

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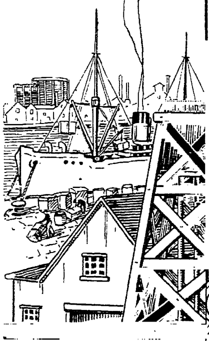

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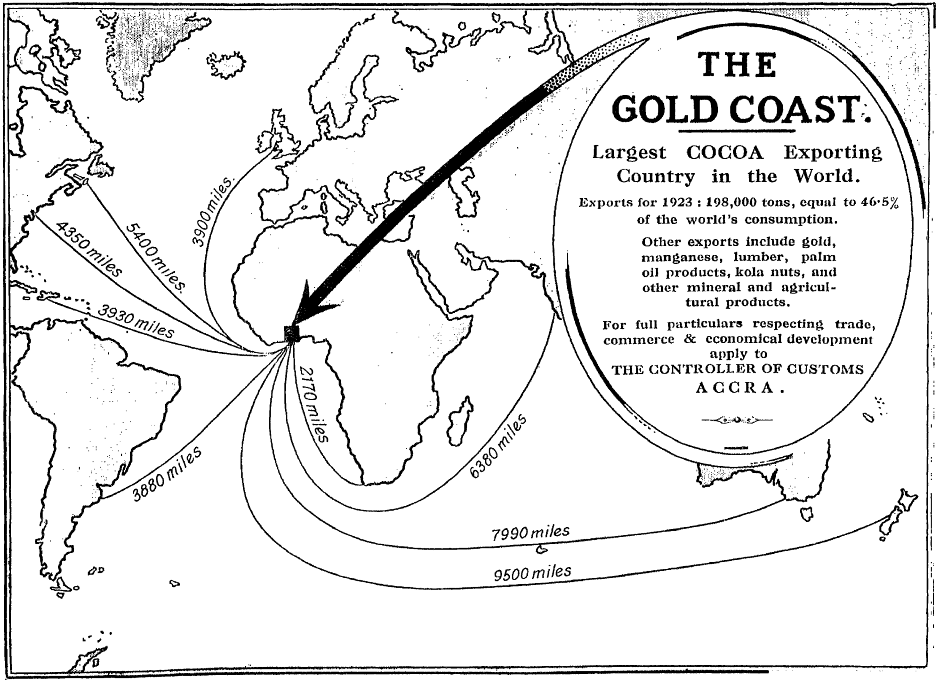
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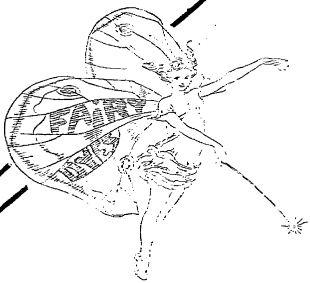

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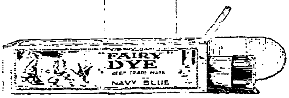

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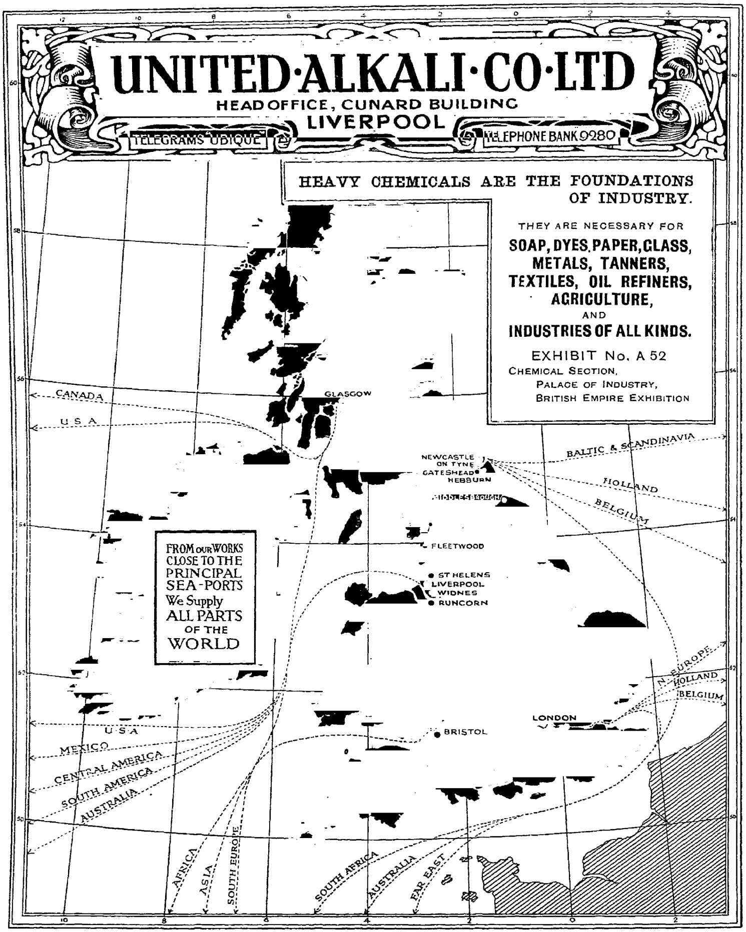

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